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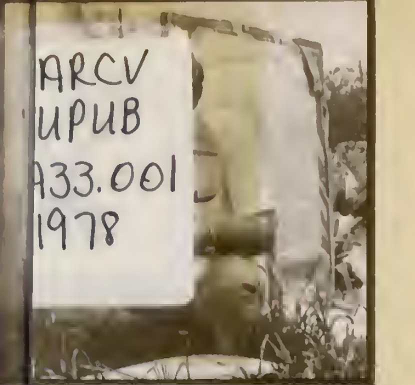

agricultural
FOR CONTINUING PROGRESS
research

ANNUAL REPORT-1978

AGRICULTURAL EXPERIMENT STATION-UNIVERSITY OF MARYLAND

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Within the past year, the Maryland Agricultural Experiment Station has made significant progress over a broad range of research activities directed toward the promotion of a sound and prosperous agriculture, and the improvement of the quality of life for Maryland citizens. This report contains a listing of all current projects and publications during the past year. Some of the activities and accomplishments in five major areas (food and nutrition, rural development, forest resources, crop production and animal production) are also featured in the report.

The gift of the Wye Angus herd from Mr. Arthur A. Houghton, Jr., is one of the most significant contributions ever made for the benefit of the University of Maryland. The gift provides an excellent opportunity to enhance the research reputation and productivity of the Station in the area of animal science, and more specifically in beef cattle breeding and management. The university is grateful to Mr. Houghton and appreciates the opportunity to build upon the excellence that has been achieved. The herd and the extensive data bank provide a broad base of research resources that requires many years of work and large investments. Our objective is to continue the program in a manner that will maintain the basic principles for which "Wye" is known, and to develop a research program that will make significant advances in beef cattle breeding and management.

The reorganization of the agricultural units of the university by the Board of Regents on November 17, 1978, provides new challenges and opportunities for the Station. The director of the Experiment Station now reports to the vice president for agricultural affairs and has responsibility for coordination and operation of the entire agricultural research program of the university. The 1890 agricultural research program of the University of Maryland Eastern Shore becomes a separately identified but integral part of the total program of the Station. The new organization will enhance cooperative research between the College Park and Eastern Shore campuses, providing improved operational efficiency and productivity.

The past year has provided unique opportunities to advance the agricultural research programs of the Maryland Agricultural Experiment Station. We appreciate the challenges associated with these opportunities to make even greater contributions to Maryland agriculture.

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W Lamar Harris

W. Lamar Harris
Director
Maryland Agricultural Experiment Station

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Since 1888, the Maryland Agricultural Experiment Station has been involved in research designed to ensure a stable, productive agriculture through the wise use of natural resources. This publicly-supported institution is mission-oriented, designed to respond to the problems affecting agriculture, forestry and rural life. With a blend of basic and applied research, the Experiment Station provides a continuing flow of new knowledge essential to the solution of current and future agricultural problems.

The Station is an integral part of the U.S. Cooperative State-Federal Research System in Agriculture and Forestry, which includes six U.S. Department of Agriculture (USDA) agencies, 56 state agricultural experiment stations, 61 schools of forestry, 16 land-grant colleges of 1890 and Tuskeegee Institute. The highly successful U.S. food and fiber system has been greatly influenced by the cooperative programs of the colleges of agriculture, state agricultural experiment stations, cooperative extension services and the USDA agencies. In Maryland the longstanding relationships among the Station, the College of Agriculture and the Cooperative Extension Service have contributed significantly to the development of a strong, effective agricultural research program.

Agricultural research in Maryland is concerned not only with improved productivity and new and improved products, processes and nutrition, but also with the conservation of natural resources, maintenance of environmental quality and the improvement of the well-being of the people of Maryland.

Within this framework, the Experiment Station maintains the faculty and facilities needed to carry out its priority research objectives, shifting emphases as new research needs arise. Research in Maryland is conducted at the College Park campus of the university, and at 10 research farms located throughout the state.

The key to the Maryland Agricultural Experiment Station's success is responsiveness to producer, consumer and environmental needs. The challenge is to maintain a balance between supply and demand, resource utilization, marketing efficiency and environmental quality.

Food and Nutrition

Richard F. Davis

Cost and Value of Foods: Consumer Information

Quality, nutritional content, acceptability and cost of food produced in Maryland have been continuing concerns of Maryland Agricultural Experiment Station scientists. Consumers are increasingly aware of the importance of acceptability, nutritional quality and safety of foods, and significant research has been directed toward efficient and effective processing, distribution and marketing.

One Experiment Station study has shown that the cost of food, measured in time worked per unit of food, continues to decline as a relative portion of total consumer income and total expenditures. From 1960 to 1973, the real cost of food declined 8 percent. In addition, in 1960 food expenditures accounted for 24 percent of the total current spending by families; this figure dropped to 20 percent in 1973. This decline would have been even greater without the considerable increase in away-from-home food expenditures.

Nutrition researchers, educators, dieticians, physicians and parents have been concerned with children's knowledge of food and nutrition. In response, a Teams-Games-Tournaments learning experience in foods and nutrition was developed and tested by Experiment Station researchers. This technique of teaching was proven highly effective in interesting students and faculty, as well as creating improvements in attitudes toward food and nutrition. Teaching curriculum guides include audio-visual aids, background information and bibliographic materials for use in teaching nutrition. This teaching tool will improve an individual's judgment in the selection of foods, and thereby improve his or her nutritional status.

Diet and Optimum Body Function

Several Experiment Station studies have contributed directly to knowledge concerning nutrition and people's use of food. A detailed study and analysis of per capita fat intake and cancer mortality over a 60-year period has shown significant positive correlations between cancer mortality and intake of both total fat and vegetable fat; however, there was a negative correlation or no correlation between animal fat intake and cancer. This finding is contrary to a widely held belief that animal fat in the diet is in some manner responsible for significant increases in cancer.

The investigators noted that "the major change in fat consumption in the United States during the 20th century is the consumption of partially hydrogenated vegetable fats (margarines, oils and vegetable shortenings)." Hydrogenation is the process used to make vegetable fats more solid at room temperatures. In this process some of the chemical bonds between atoms and the fatty acid molecules are changed. These altered chemical bonds may be the cause of the cancer problem. Preliminary evidence from other studies indicates that fatty acids with the altered bonds affect the function of cell membranes, possibly making it easier for cancer-causing chemicals to enter the cells. Fatty acids containing these altered bonds are given the name "trans" fatty acids. This review could well be the basis for rethinking the recommendations associated with the national dietary goals, and many of those recommendations made by other agencies.

A requirement for essential fatty acids (EFA) in human nutrition has long been recognized. Symptoms of this deficiency occur in human infants if they are fed improper formulations made of skim milk and sugar, or are breast-fed by EFA-deficient mothers. Adults fed intravenously over long periods of time on solutions devoid of essential fatty acids also show clinical signs of EFA deficiency.

Experiment Station research has been directed toward investigating the consequences of EFA deficiency on central nervous system development and myelination of nerve fibers. Researchers observed a profound retardation in brain development and marked reduction in some biochemical markers of nerve myelination in EFA-deficient mice. The retardation in brain development may be as long as 1 week in the mouse, corresponding to a delay of 7 months in a human infant. The data clearly suggest that prolonged exposure of a fetus to an EFA deficiency can have a potentially significant effect on its mental development, and perhaps motor skills, since lack of myelination frequently interferes with normal motor activity. Continuing research is under way to define the periods within pregnancy when the brain is most susceptible to this form of nutritional deprivation, and to determine the extent to which these effects are reversible. This research reinforces existing knowledge of EFA deficiencies, and clearly demonstrates the critical nature of adequate diets for pregnant mothers and infant children.

Although the role of many trace minerals such as iron and copper in human nutrition is now well documented, the role of zinc in mental retardation has been studied only in foreign countries. Sickle-cell anemia, found in many blacks, has occurred at the same time as low levels of zinc, according to studies in New York and Michigan. Research in Maryland was undertaken to study sickle-cell patients in the Baltimore-Washington area, and the relationship of zinc and copper in this group compared to a control group. The sickle-cell patients in this metropolitan area did not exhibit low zinc levels; the zinc levels were normal in the plasma, red blood cells, urine and hair of the sickle-cell patients compared to other healthy controls. However, elevated levels of copper were found in the sickle-cell group compared with black and white controls. The zinc level appears to be related to environmental factors other than sickle-cell anemia.

Quality Food for Less Energy

Many food processing procedures require large amounts of energy to prepare foods for distribution and sale, prevent bacterial contamination, and assure stability during storage. Improving the efficiency of food processing operations by reducing the energy required is a significant segment of Maryland Agricultural Experiment Station research.

One such major research effort involves the evaluation of a system of infusing a falling film of milk with steam to sterilize the product. Research has established that milk sterilized in this way can be stored for an extended period of time with no bacterial deterioration. Flavor and other characteristics of milk, essential for consumer acceptance, are highly acceptable in this product.

Faye Feldstein tests the bacteria level in a sample of sterilized milk. Experiment Station researchers are interested in using the milk as a medium for cultured products such as yogurt and cottage cheese.

Much of the energy used in milk processing and distributing is required to maintain milk at refrigeration temperatures throughout its storage life, and to provide special handling, trucking, and storage conditions as it moves into the home and is used by the consumer. This aseptic milk has the potential of providing tremendous energy savings after the milk is processed. Storage for several months without refrigeration appears practical. Additionally, milk can be handled along with other food products in a regular warehousing system, eliminating special handling and added labor and trucking costs. Research is continuing on the evaluation of this product which, if found to be technically feasible to package and distribute, could have major impact on the use of milk in the future, including its total cost, costs in terms of energy, and broader availability.

Research is under way to study other characteristics of this milk, including its potential as a growth medium for bacteria which produce cultured products, such as yogurt, buttermilk and cottage cheese. Scientists at Ohio State University are cooperating with Experiment Station scientists in evaluating enzyme activity which may be present in milk several weeks after sterilization. The data are incomplete and need statistical examination, but some interesting observations have been reported. Freshly-processed milk has extremely low enzyme activity for xanthine oxidase, phosphatase and protease. Xanthine oxidase levels continue to decline for 1 month, followed by slight elevation. However, after 3 months of storage, the activity of this enzyme is still less than its original level. Residual phosphatase levels were inversely related to sterilization temperatures soon after processing. This enzyme also undergoes a slight inactivation-reactivation during storage; however, the residual activity after prolonged storage is still less than its original value.

Protease activity remains at very low levels if the holding time is kept at 1.5 seconds for all the temperatures of sterilization. Holding times of 9 seconds resulted in a greater rate of reactivation. Low levels of lipase activity persisted throughout the storage of sterile milk samples at both 40°F and 75°F. Although some of the 60-day old samples had evidence of slight rancidity, the data accumulated thus far indicate that a marketable sterilized milk can be obtained by processing in this system. Low residual levels of enzyme activities do not appear to adversely affect the overall acceptability of the product.

Alternative methods for storing foods with limited energy expenditure include a study of an entirely new method of food processing by gas exchange. The principle of this "gas pak" process is that practically any food material can be rendered stable when oxygen is removed and enzymes and microorganisms are inactivated. This was accomplished experimentally by evacuating gases in and around the food tissue, then breaking the vacuum with an enzyme-destroying gas followed by a bacteria-destroying gas. Thus far, potatoes, apples and sweet corn have been stabilized by the "gas pak" method. Work is now under way to determine if these products are sterile, retain sensory and nutritional quality even if stored at ambient temperatures, and do not involve any toxic residues. Successful use of this method of food preservation could significantly reduce energy requirements and costs.

Scientists have also been exploring ways to reduce the energy required for conventional food preservation and storage systems. In the case of canned foods, a major energy expenditure is the container itself. New, partially plastic containers of different shapes were developed in an effort to produce a superior "canned" product in a cheaper container.

A current viable candidate is the retortable pouch. This container is made largely of plastic in the form of an envelope. Because of its geometric properties, it can be sterilized more quickly and with less application of heat than the conventional cylindrical can. The resulting food product is more like fresh or frozen than canned. Preliminary results from preparing and storing food in retortable pouches showed that standard vegetables were in all cases superior when frozen. Those in the retortable pouches were superior to conventionally canned vegetables immediately after processing, losing their advantage after several months' storage at ambient temperatures. Prepared and precooked products were equal to frozen when retorted, and both the prepared foods that were frozen and those that were packed in pouches remained substantially superior in quality to those that were conventionally canned.

An Experiment Station study just completed on frozen foods, a large sector of the food industry, demonstrates that significant energy savings can be achieved in storing frozen foods. Fruits and vegetables were stored up to 12 months at a constant -10°F, the usual recommended storage temperature, and were compared with similar products stored at -10°F, but with the electric power turned off at night. In another storage room, temperatures were maintained at -5°F, and in a third room at 0°F. In each case the power was shut off at night. Maintaining temperatures at -5°F, instead of -10°F, resulted in a 15 percent saving in power. Turning the power off completely at night resulted in a total power saving of 22 percent with only a minor reduction in sensory and nutritional quality. However, when temperatures were permitted to rise to 0°F and higher, there was an additional power saving of only 7 percent, accompanied by a substantial loss in sensory quality. Similar studies are now in progress with frozen meat products. A computer program was deve-

Significant energy savings can be achieved by raising the storage temperature of frozen foods 5°F. Dr. Amihud Kramer checks the settings on one of the compressors used to determine energy inputs.

loped and tested for some 30 different frozen food items to determine the storage conditions which will maximize energy savings and minimize quality losses.

Improving Processing Efficiency

Improving and maintaining the quality of a number of food products while developing increased efficiency in processing procedures is important for the continued health and effectiveness of the food processing industry. Alternative methods of producing frozen poultry parts were evaluated by chemical, physical and sensory methods. Variations studied included freezing immediately after hot cutting and freezing after chilling. Results of a taste panel analysis indicated that poultry frozen immediately after hot cutting is an acceptable product. No difference in tenderness was observed for any freezing methods. Different freezing techniques have individual advantages, but in the final evaluation all produced an acceptable product.

Poultry and other meats undergo continuing enzyme metabolism and activity following slaughter. Experiment Station researchers have examined exposure to microwave energy as a possible method of improving the tenderness of freshly slaughtered broilers through its potential for reducing this enzyme action. Measurements of adenosin triphosphate were made as a marker indicating the relative level of rigor mortis, and thus the level of tenderness. Glycogen stored in the muscle was also measured to determine the level and rate of enzyme activity. In addition, taste panel and shear force evaluations were used to determine the effectiveness of microwave energy on carcass tenderness.

Although chemical changes were modified by exposure to microwave energy, there was no effect on the resulting tenderness of the cooked product from any of the treatments. In additional studies, no differences were observed in water pickup, shear press values, measures of tenderness or cooking losses when four treatments for aging and chilling before and after cutting were compared.

Poultry halves produced by either splitting or removing the backbone and aging for 2 hours at 73°F were tougher than halves from poultry chilled prior to cutting. Poultry halves cooked immediately after hot cutting had less total and volatile cooking loss than halves chilled before or after production, and less drip-loss than those chilled prior to cutting. Breast muscle from halves chilled for 2 hours before halving were more tender than those from other treatments. Breast muscle from halves chilled after hot cutting were redder than from other treatments. The method of preparing the halves made no difference.

Many plastics provide convenient and efficient wrapping material for fresh food products; however, it is possible that the plasticizer from these wrappings may migrate into the foods. Experiment Station researchers have studied the migration of plasticizer from a commercially available plasticized film, polyvinylchloride, polyvinylidenechloride, into food and food models. Model food systems in contact with plastic film were treated with microwave energy for 4 minutes. No migration of the plasticizer was observed for carbohydrate and protein food products at different levels of content. The addition of corn oil resulted in migration of plasticizer in proportion to the amount of oil present from 0 to 30 percent by weight. The safety of the emigrant identified as acetyl-tributylcitrate was evaluated by a bacterial test for mutagenesis, and was found to be not mutagenic.

A condition of excess fat in the skin of birds, called oily bird syndrome, was investigated to determine its cause and prevention. The results indicate that oily bird syndrome is caused mainly by high rearing temperatures and alterations in diet; older and heavier birds have a higher incidence of this syndrome. Visual scoring is a satisfactory method of determining its presence.

According to a study conducted by Dr. Effie Hacklander, the cost of food, measured in time worked per unit of food, has declined. Here she checks some of the data used to substantiate this finding.

A 14 percent increase in the yield of apple solids has been obtained in a research procedure for extracting fruit juices and natural plant pigments, in comparison with a usual commercial press unit. Maximum solid yields for the extraction system studied were about 92 percent compared to 75 percent for the press method. The extraction system involves first the heat denaturation of the plant material, then a diffusion of material in solution from the cells, and finally a solid liquid extraction process in which soluble components are transported away from the remaining solid material. The experimental equipment is designed so that it can be scaled up to commercial size processing equipment. The increased yields from this process will greatly improve the economics of preparing apple juice concentrate, and will provide a high quality single strength apple juice in commercial markets.

This experimental equipment being used by Dr. Robert Wiley can extract pigments from the red table beet. These pigments may replace red dye number 40, a possible carcinogen.

Red and yellow pigments (betalenes) from the red table beet have also been recovered using this research apparatus. The most efficient methods for recovery have been established; these important pigments may eventually replace certain widely used dyes, such as red dye number 40, now being questioned as a possible carcinogen.

With the philosophy that no potential food product should be wasted, researchers have explored the possibilities of using the solid phase from juice extraction products; for example, sweet potatoes will provide a useful product for a potato chip after the excess sugar has been removed by the solid liquid extraction process. In the past, this high level of sugar in sweet potatoes has made them unsatisfactory for chips. Cold-stressed white potatoes also have a high sugar content. Although extracted potato chips are somewhat lower in flavor, they should be satisfactory in competition with sugar-free white potato chips and other snack foods in the market place.

The quality of concentrated or dehydrated foods is adversely affected by the level of heat applied in the processing. It is well recognized that freeze-concentrated and freeze-dehydrated foods provide the highest quality concentrated food products. However, this process is also the most expensive. A major expense in freeze concentration is the occlusion of some solid food particles in the ice which is removed. A prototype freeze concentrator has been developed which produces practically pure ice so that almost no food is lost in the process. This "centrifugal freeze concentrator" contains a rapidly rotating freezer element with practically pure ice attached to it. Solids, both soluble and insoluble, move away from the rotating shaft and are all retained.

A quantitative evaluation of the loss of taste, flavor and nutritional quality during marketing and storage of vegetables has been made. The results of the research indicate that ascorbic acid (vitamin C) is the most sensitive to loss during storage. In many instances this vitamin can be used as a marker to reflect general changes in quality. Thiamine (vitamin B_1) and vitamin A are also lost during storage. The total carbohydrate level may be reduced as a result of respiratory activity during extended storage at relatively high temperatures. Protein levels are rarely affected, but protein availability may be reduced in foods not protected from oxygen and stored at high temperatures. These losses in nutritional and sensory quality occur even in canned foods, unless they are stored at low temperatures. In frozen foods maintained at 0°F or below, there is little change in nutritive value, but a slow change in sensory quality.

Continued respiration of many vegetable products following harvest and during storage and distribution detract from the fresh quality of the product, and fundamental respiration reactions are being studied to determine the actual chemical pathways taking place. As a result, controls more sophisticated than the empirical treatments now used in storing the material in cold temperatures will be used to maintain quality during storage. Cyanide, an enzyme-inhibiting chemical, has practically no effect on the rate of oxygen intake at ambient storage temperatures. However, at temperatures below 50°F the rate of oxygen intake is almost doubled in the presence of cyanide. Cyanide appears to have a direct stimulatory effect on respiration rate at low temperatures. Further research is under way to investigate the mechanism of this stimulatory effect, and to devise procedures to more effectively maintain quality during storage. Sweet potatoes are the model under study.

Rural Development

Allen M. Prindle, Dean F. Tuthill
and William J. Bellows

The Maryland Agricultural Experiment Station, through its rural development research program, responds to the needs of a complex and rapidly changing rural situation ranging from the rural-urban fringe to the remote areas of the state.

The transition zones surrounding the major metropolitan areas are experiencing pressure for development. Urban residents who leave the city for the perceived amenities of rural living may alter or even destroy the same amenities they seek. The pressures for change in the rural-urban fringe are great, prompting modifications in lifestyle, changes in methods and level of delivery of community services, and new uses of the region's resource base.

The more remote areas of the state share some problems with the rural-urban fringe, but have additional needs. For example, unemployment, especially among minorities, is particularly serious in these areas. These problems require different approaches and solutions. In all cases, alternatives and trade-offs must be evaluated before any plan of action is adopted.

The rural development process may be described as the means to reach the goal of improving the quality of life of nonmetropolitan residents. To attain this goal, the rural development process must include identifying problems, examining alternative methods of addressing problems, determining the consequences of alternative actions, and selecting and implementing actions consistent with the community's appraisal for improved quality of life for its residents. It may involve enlarging the local resource base or offering ways of eliminating barriers to reaching goals. A complicating factor is that problem identification and proposals for solutions may originate at different levels, including national, multistate regional, state, multicounty district and local or county, depending on the specific problem. The development process involves a wide range of individuals and groups with differing and sometimes conflicting goals, priorities and strategies. Research input into rural development issues must respond to these levels of concern by identifying potential conflicts and resolutions. The rural development process is not complete until the selected plan has been implemented. In addition, the plan must be constantly evaluated to determine how adequately it responds to change.

Current Rural Development Research

To begin addressing the complex problems of rural development, the Maryland Agricultural Experiment Station has initiated several research projects designed to solve major problems facing nonmetropolitan residents and to obtain additional information to assist these residents in reaching the goal of improved quality of life. The scope of rural development research efforts covers five interrelated areas: human development, environmental improvement and preservation, economic development, community facilities and coordinating activities.

Two Experiment Station projects are under way in the human development area; one deals with the provision of mental health services to rural areas and the second focuses on the evaluation of leadership within rural youth organizations.

The provision of health services is a high priority in the rural areas of Maryland. Despite this priority, there is a large disparity between mental health services in rural and urban areas. To document this disparity and to recommend solutions, Maryland researchers compared the distri-

Young leaders from the Future Farmers of America participated in a survey conducted by Dr. Clifford Nelson to measure leadership traits and to develop personality profiles of various leadership levels.

bution of mental health facilities and resources in rural and urban areas. The results of this research have been used by the Rural Mental Health Task Panel of the President's Commission on Mental Health in recommending policies designed to provide improved health services to rural areas.

Another human development project examined the leadership qualities of young leaders from the Future Farmers of America (FFA) and 4-H organizations. Experiment Station researchers used a personality inventory to measure personality traits and differences in these traits among members, local officers and state officers. The results of this study were used to develop personality profiles of the various leadership levels in these organizations, and to show the relationship between style and ability traits and actual leadership levels.

Environmental improvement and preservation is the second major segment of rural development under examination; this area is of particular importance in Maryland because the size of rural areas of the state is continually shrinking.

The movement of people in and out of rural areas affects the lives of all rural residents. To assess the impact of in and out migration and population redistribution, Experiment Station researchers identified the number and characteristics of migrants in the Northeast. From the initial analysis of the data collected, specific counties will be studied to determine the impacts of population increases, decreases and stability on the social structure, economy and quality of life of the residents.

A current research project is concerned with examining the trade-offs between the increasing demand for outdoor recreation in a natural setting and the economic activity generated through development in the Appalachian region. Researchers have estimated the greatest resident satisfaction, subject to specific constraints, and will analyze the expenditure patterns of various types of park users. This information will be useful to the Maryland Park Service in deciding how to allocate their capital construction budget.

Research in the area of economic development is concerned with an economic analysis of agricultural employment, unemployment and production changes in rural areas, and the determination of optimum farm organization for limited resource farmers. Researchers have recognized the trend toward a more highly mechanized, less labor intensive agriculture, resulting in the release of farm labor in all of Maryland's counties. This trend in agricultural employment opportunities has created a number of problems for both urban and rural areas. In response, one Experiment Station project examines alternative employment opportunities for the released farm workers, and identifies some of the specific programs needed to provide employment. Programs to teach nonagricultural skills, attract nonagricultural businesses to rural Maryland, train local leaders and improve transportation have been identified as important in solving the problems of displaced agricultural labor. Another project dealing with economic development involves helping limited resource farmers better organize their farm operation for the greatest economic benefit. A profile of the limited income farmer was drawn up in terms of age, race, size of farm, type of farming and location.

Another broad area within rural development research involves improving rural community facilities, especially housing. Experiment Station scientists investigated the problem of providing quality housing for rural low income families by surveying families throughout the state to determine owner satisfaction with a Farmers Home Administration (FmHA)-financed house. The greatest source of dissatisfaction among the home-

The effects of major social and economic changes on the quality of rural life are being studied by Dr. James Longest, Eugene Owen, Dr. Dan Tweed and Dr. Mildred Konan, to establish county planning priorities.

owners was the cost of utilities. As a result, researchers are now studying ways to improve the structure, including solar collectors, to lower energy costs. Fifteen modified FmHA houses are being built in the Appalachian region with solar attic heating systems. Data on their construction and operating costs will be compared with the benchmark houses to see if the percentage of income spent by rural low income families on housing can be reduced.

Coordinating the activities of rural development involves comprehensive planning, zoning, fiscal management and coordination among government units. Most rural development scientists believe that land use planning provides a linkage between economic development and community facilities. Especially important is the timing and sequence of the conversion of agricultural land into developed uses. With this in mind, researchers are evaluating the impact of the proximity of open space on the market value of housing and property tax receipts in Columbia, Maryland. The results of this study will provide information on the implications of similar land use plans.

In another Experiment Station project, researchers refined measures of quality of life to evaluate the effects of major social and economic changes during the past two decades. This information will be of value to decisionmakers in evaluating the consequences of alternative policies that have an impact on the quality of life in rural areas. Results of this research have helped the Talbot County Council of Health and Social Services establish policies on transportation services and interagency cooperation.

Future Rural Development Research

Because of the broad range of subject areas and the complexity of the rural development issues, an interdisciplinary research approach is necessary to meet existing and emerging problems. It will be important to ensure that future research covers priority areas and provides for the input of various disciplines. In addition to generating information through well-planned research, the Experiment Station must have an effective communication system to interpret and disseminate the research results. This role is especially important because research implications may be different, for example, in rural-urban fringe areas than in remote rural areas.

Future research efforts must include describing and predicting change, identifying the impact of change on residents, and evaluating trade-offs associated with development alternatives. An important question is: who benefits and who is burdened by existing, predicted or structured change, and is this consistent with the goals of the community?

Experiment Station researchers like Dr. Gertrude Fish are studying the possibility of lowering home utility costs for low income farmers by installing solar collectors.

As part of a project designed to help limited resource farmers, Richard Douglas, right, talks with a Southern Maryland farmer about organizing his tobacco operation for the greatest economic benefit.

Forest Resources

John F. Kundt

Maryland's forest resources provide a diversity of forest products, from the northern hardwoods of Western Maryland to the southern pines of the Eastern Shore. The 2.5 million acres of commercial forests are mostly in rural areas, and produce the bulk of the state's lumber, poles, piling, veneer, railroad ties, pulpwood, pallets, boxes and crates, and maple syrup. However, the commercial forests in Maryland are shrinking every year due to urban development, powerline right-of-way clearing and agricultural land clearing. This taxes the remaining forests to produce more wood to keep up with the demand.

Fortunately, unlike many other natural resources, forest resources are renewable. If technological advances developed through research keep pace with increasing demands on forests for their many values, shortages like those in energy need never occur. The goals of the Station's forestry research are to develop the scientific know-how to manage the nation's forests, and to meet the demand for wood and fiber while providing abundant water, wildlife, recreation and other values of the forest environment.

Scientists conduct research in forest economics, tree growth and development, forest insects and diseases, forest fertilization and forest recreation. The production of forest products and scientific forest management are adversely affected by rising land values and rising interest rates; therefore, research dealing with economic values is of utmost importance.

Economics

The Maryland Agricultural Experiment Station is working with the Maryland Forest Service to study the effect of the Forest Conservation and Management Act, enacted in Maryland in 1962. This act was meant to encourage increased forest productivity on nonindustrial private forest land by "freezing" property taxes on forest land at the current rate. In return, forest landowners must follow the best management practices specified by a professional forester in a written forest management plan. At the end of the contract period, taxes are reapportioned and a deferred tax is collected. This law has had little effect on timber production, less than 10,000 acres out of 2.5 million acres have been placed in the program, mostly from the metropolitan counties rather than the timber-producing rural counties.

According to Experiment Station research results, forest landowners failed to sign the agreements because: 1) assessments on forest land were not increasing in many cases, 2) the tax "roll-back" provision included in the act could cause forest landowners to pay more taxes under the program than if not enrolled in the program and 3) the act failed to provide incentives for new owners to enter forest production because of rising land values and length of time required to produce forest products.

Increasing the productivity of pine trees on the Eastern Shore has been a concern of Dr. John Kundt. The economic feasibility of this crop is dependent upon finding the optimal thinning and harvesting schedule.

The question of whether or not management of pine trees is economically feasible on the southern Eastern Shore, especially intermediate thinnings before the final harvest cutting, has been posed. In response, Agricultural Experiment Station investigators, in cooperation with Maryland Forest Service personnel, studied pine forest resources on the Eastern Shore. They found that under optimal management of loblolly pine forests, two thinnings, one at age 30 and the other at age 35, would produce the greatest accumulated income at harvest time, age 40. The income value depends on the productivity or fertility of the land, and the value can more than triple for the best growing sites.

Maryland has only one pulp mill; however, raw material is supplied to two pulp mills outside the state. Economists are now in the process of a feasibility study to determine whether or not another pulp mill could be built in a five-state area including Maryland. Preliminary results indicate a hardwood pulp mill might be feasible in the five-state area to manufacture soft sanitary paper products, such as tissue, towels and diapers. The high energy cost of transportation has increased the cost of all products that have to be shipped long distances to market. The solution, say economists, is to locate the pulpmill in the area of timber supply and ship raw pulp to the manufacturing plants near metropolitan areas, close to the marketplace.

Growth and Development

Maryland Agricultural Experiment Station researchers have experimented with using forest and grass buffer strips to control animal waste runoff into streams. When streams were monitored below the area treated with manure and within the same watershed, no evidence of fecal pollution was found. The fecal organisms, nitrogen, phosphorous, potassium and sodium had moved less than 25 feet from their disposal site. These examples point up the potential for using vast acres of forest to renovate wastes in environmentally acceptable ways.

Studies in cooperation with the Beltsville Agricultural Research Center and the Maryland Forest Service on the use of compost made from either raw or digested sewage sludge and wood chips indicate that the optimum levels of application are between 50 and 100 dry tons per acre for growing forest tree seedlings. Soils amended with compost tend to produce more weeds, creating a severe weeding problem in softwood seedling beds, because of their slower rate of growth. Seeds of softwood trees sown in compost-amended soils tend to germinate earlier, resulting in increased susceptibility to late frost damage. Neither of these is a problem in hardwood seedling beds, because the seeds germinate later and the seedlings can readily outgrow most weeds.

An Experiment Station research project now in progress is designed to study the long-term effects of using sewage compost on soil, and the biological effects of compost on microorganisms in the soil on two tree species — hybrid poplars and white pine seedlings. The hybrid poplars have shown a tremendous increase in height growth over the controls; the white pine seedlings, however, are showing very little response to the addition of compost at this time. Heavy metal deposits will be studied both in the soil and in the two tree species to determine their long-term effect on plants.

Other research studies have helped answer questions related to tree growth on planted pine seedlings on old sanitary landfills. For example, methane gas is produced from decomposing solid wastes, and is toxic to most trees. However, Experiment Station studies have shown that Virginia pine trees which had a beneficial fungus (Mycorrhizae) around the feeder roots showed 50 percent less damage by the gas. Methane gas causes stunting of the roots of Virginia pine, and the addition of the beneficial fungus counteracts this stunting effect.

Nurserymen have long sought a means of mass reproducing a single well-formed tree, so that each offspring would have identical characteristics of the parent plant. This idea prompted scientists to experiment with needle clusters of white pine and ponderosa pine to find a method which would produce new plants from rooted needle clusters on a commercial basis. A great variation in rooting was observed in both tree species; some needle clusters from an individual tree rooted 100 percent while needle clusters from other trees were very poor. Unfortunately, the study showed that rooting needle clusters from white or ponderosa pines for commercial production is possible but not practical.

This water sample being prepared by Dr. Duane Wolf will show whether or not grass buffer strips are effective in controlling animal waste runoff into streams.

A racial variation study of various conifers is being conducted in cooperation with the Maryland Department of Natural Resources, the U.S. Department of Agriculture and the Canadian Ministry of Forestry. Seeds were collected from 100 different locations in the United States and Canada. Growth measurements indicate that some trees grew twice as fast as others in the same planting; some seed lots grew 10 to 20 percent faster than the average in all 17 planting locations. More testing of those fast-growing lots will help establish the fast growers in seed orchards for the genetic improvement of forest trees.

Recreation

The Maryland Forest Service was concerned about the adequacy for recreational use of the state forests in Western Maryland. Researchers from the Maryland Agricultural Experiment Station studied the carrying capacity of recreational use of these state forests; the results have been used by forest managers in planning and management to satisfy

Maryland's forests are an important recreational resource. Dr. James Longest, right, has worked closely with park rangers to determine the carrying capacity of recreational land, and to protect the forests' resources.

the people who use the forests, and to protect the forests' resources.

A new Experiment Station study on the behavioral assessment of crowding and environmental deterioration in outdoor recreation settings is getting under way. The study, which is closely coordinated with the Department of Natural Resources, will evaluate the impact of that department's policy decisions on the behavior of turkey hunters in Western Maryland forests. Researchers will assess the impact of recreation on the natural resources of the forest as a habitat for wild turkeys. How the closing of the fall hunting season affects the number of hunters in the spring season and their perception of "crowding" during hunting will also be studied.

Insects

Maryland foresters needed definitive information on the Nantucket pine tip moth and its feeding habits; this insect feeds on pine tree tips and reduces their growth. Recent studies on the tip moth at the Maryland Agricultural Experiment Station have established that a loblolly pine plantation becomes essentially resistant to tip moth injury once the trees reach a threshold height of 3 meters. Under heavy levels of infestation, loblolly pine can be retarded as much as 5 years in reaching that height. Present studies are directed toward manipulating the abundance of natural enemies of the tip moth in such a way as to minimize populations in plantations that have not reached the threshold height. Approaches being studied include modifications of stand characteristics to encourage natural enemy populations, and the development of rearing methods to increase natural enemy numbers.

Since wooden fence posts are in great demand, the market for black locust posts has greatly increased. The quality of the posts is judged by straightness, size, heartwood and freedom from such defects as locust borer holes. Entomolgists are studying the locust borer to determine the damage in different size and age classes of trees, and the severity of attack in mixed forests of locust and other hardwoods compared to forests of pure locust. The results of this study will indicate a cultural practice that will help reduce locust borer damage and increase the value of fence posts and other locust products.

Forestry research at the Maryland Agricultural Experiment Station utilizes the expertise of scientists from many different disciplines and cooperates with state and federal forestry agencies and industry. This cooperative effort has improved the use of Maryland's forests for wood and fiber, abundant water, wildlife and recreation.

Carol Paige examines a loblolly pine for tip moth damage. This crop is being modified to encourage natural enemy populations in an effort to control this pest.

Wye Angus Herd

This past year the Maryland Agricultural Experiment Station received a contribution significant in both economic and research terms. The internationally-known Wye Angus beef cattle herd was the major portion of a gift from Arthur A. Houghton, Jr., owner of Wye Plantation in Queen Anne's county.

Houghton began the herd in 1938 with 18 heifers and a bull calf. Through the years, no other females were purchased, and the herd was closed to outside bulls in 1959. This has enabled Wye to compile one of the most detailed sets of individual performance records available on any herd of Angus cattle.

The herd has grown steadily in quality and reputation. During the mid-1960's, Wye Angus gained wide recognition within the breed and throughout the entire domestic beef cattle industry for its production of performance-tested cattle of greater scale.

In May 1978, the Wye Plantation Angus bull sale was held. A one-third breeding interest in the main herd sires was retained for use in the Experiment Station's research program. For the present, the herd is being continued at the Wye Plantation under an arrangement between the Experiment Station, the Aspen Institute and Mr. Houghton.

In presenting the herd, Mr. Houghton remarked: "It has long been my desire that some assurance be found for the basic herd of Wye Angus to remain intact and for scientific work to be continued. Acceptance of the Wye herd by the University of Maryland as a gift from me and my family now makes this possible."

Present at the Wye Plantation Angus bull sale, from left to right: Mrs. Arthur A. Houghton, Jr., Mr. Houghton, Mrs. Wilson H. Elkins, Dr. Elkins, Dr. Frank L. Bentz, Jr., and Dr. W. Lamar Harris.

Animal Production

Edgar P. Young

An efficient modern animal agriculture combines locally available crop-producing resources with sound management, competent labor, capital resources and current technology to increase economic returns to farmers and their communities. For example, cattle and sheep harvest forage crops in Western Maryland with a minimum input of labor and capital facilities, and as a consequence increase the return to farmers of this agricultural land. Additionally, poultry and swine enhance the value of corn and soybean produced on the Eastern Shore.

Animal production research of the Maryland Agricultural Experiment Station is directed toward solving current problems which can limit the overall efficiency of animal production, and developing information which will keep Maryland's animal agriculture competitive in the future.

Animal Health Research

Modern animal production programs require the use of sophisticated health maintenance programs and the most recent techniques for diagnosis and treatment of disease outbreaks. The increased size of animal production units makes them not only more efficient and profitable, but also more vulnerable to disease outbreaks. Prevention of virus-caused disease by drug treatment or vaccination is the safest and most economical approach to dealing with this threat.

As an example of this type of research, two drugs, 2-deoxy-D-Glucose (2-dG) and glucosamine, were introduced into cultures of bovine respiratory syncytical (RS) virus to determine their limiting effect on the growth of the virus. Both drugs inhibited growth when added up to 12 hours after infection of the cells. The inhibitory effect of 2-dG was reversible by Mannose; glucosamine could not be reversed by Mannose. Thin section electron microscopic studies indicated production of a large amount of the virus in the absence of these drugs, and mature virions exhibited numerous spike-like projections from their envelopes. The amount of the virus produced in cultures treated with 2-dG and glucosamine was greatly reduced, and the virions lacked the characteristic surface projections.

Equine herpesviruses are being studied as they relate to abortion in mares. Particular strains of equine herpesviruses, known as EHV1 and EHV2, were used to determine how these infectious agents affect animals during the course of infection, and how certain white blood cells and other segments of an animal's immunity and disease resistance systems react to the infection. Information gathered in these experiments is now being used in a study of approaches to resistance and immunity to equine herpesvirus infection, and can be used in studying other diseases caused by the same virus, such as rhinopneumonitis in foals.

Isolates of infectious bronchitis virus from Eastern Shore poultry flocks have been serotyped to determine whether or not present vaccines and methods of vaccination can be improved. This work is representative of much research in animal production that responds to the dynamic and constantly changing industry needs. Research can provide the knowledge base for more effective vaccines or vaccines to respond to shifts in the virulence of virus strains.

Effective diagnostic procedures are essential to economical animal health programs. A new method called enzyme-linked immunosorbent assay (ELISA) has proven effective in the detection of many diseases and is now under study in the field and in the laboratory. Although it is too early to draw definitive conclusions about its applicability, current results suggest that it can be a useful tool in diagnosing poultry diseases. In the past year, researchers have controlled infectious laryngotracheitis (ILT) by implementing proper vaccination procedures, although no strain differences were found.

Reproductive Efficiency

Economic efficiency in animal production must begin with reproductive efficiency. The complex process of reproduction works reasonably well most of the time; however, maximizing reproductive performance continues to be an elusive goal in animal agriculture. Precision in detecting estrus contributes to better timing of artificial insemination and a higher fertility rate. Pedometers, devices which monitor walking activity, have been attached to the legs of cows to measure increased walking activity, a sign of the estrous period. Pedometers detected 73 percent of the cycles, and heat mount detectors, also used in the study, detected 73 percent. Combining both observations accounted for 92 percent of the cycles indicated by progesterone under laboratory conditions. However, the heat mount detector produced too many false positives (mounts but no estrus), and investigators concluded that only pedometers are sufficiently accurate to warrant further study.

Maintenance of pregnancy throughout the gestation period of the mare continues to be a problem with a substantial portion of brood mares on Maryland horse breeding farms. To combat this tendency, Experiment Station researchers injected the hormone progesterone into mares with previous histories of abortions, and studied the effect of this procedure on the mare's own progesterone levels. Researchers concluded that 250 milligrams of progesterone injected every 2 to 3 days is necessary to maintain increases in circulating progesterone levels. The influence of this procedure on maintaining pregnancy was not evaluated in these experiments; however, mares carrying twins were found to have a substantially higher progesterone assay than mares carrying one foal.

Improving fertility of mares after foaling has been investigated through a biopsy technique used to study the uterus and its capacity for quickly establishing a new pregnancy. Forty-five uterine biopsies from 21 mares, following foaling, were studied for changes favorable to conception after being treated with progesterone. The results suggest that progesterone treatment improves the fertility of mares bred during the "foal heat" period, and thus increases overall reproductive efficiency.

The amount of time that sperm cells remain capable of fertilization is important in the management of stallions on breeding farms. Investigations of this process indicate that stallion sperm cells retain their capacity for fertilization for as long as 72 hours after mating; however, studies of conception rates for mares mated at 72-hour intervals would be necessary before this practice could be recommended to breeders.

Progress in Poultry Production

Over the last decade, the growth rate of broilers has increased so rapidly that most birds are processed before the age of 8 weeks. Improved genetics, disease control, management and nutrition have all contributed to the better growth rate. With this progress, new nutritional requirements must be determined, and diets reevaluated to meet the changes taking place in the industry. Females grow at a slower rate than males, so they do not require as much protein and amino acids as males. However, this difference is relatively small; at the present time, it is not economically feasible to separate males from females and feed them different diets.

Broilers on the Eastern Shore are fed mainly locally-grown ingredients, such as soybean meal and corn. In a corn-soybean diet, the amino acid that is most likely to be in short supply is methionine. More methionine can be incorporated into the diet either by using ingredients high in methionine or by adding a form of synthetic methionine. The next most limiting amino acid, lysine, is being reevaluated by Experiment Station researchers to determine the lysine requirement after 3 weeks of age. To determine the lysine requirement, the rate of growth of chicks and the amount of feed required per pound of gain is measured. If the diet is deficient in lysine, the birds will develop a craving and will eat the feathers that lie on the litter; the number of feathers found on the floor can also be used to estimate the lysine requirements of the birds.

A recent Experiment Station study has shown the importance of placing chicks in rearing facilities as soon as possible after they have been removed from the hatchers in the hatchery. In the experiment, chicks that were placed in the rearing facilities 4 hours after they had been removed from the hatchers were heavier when they were processed than chicks that had been placed in the test facilities 24 hours after being removed from the hatchers.

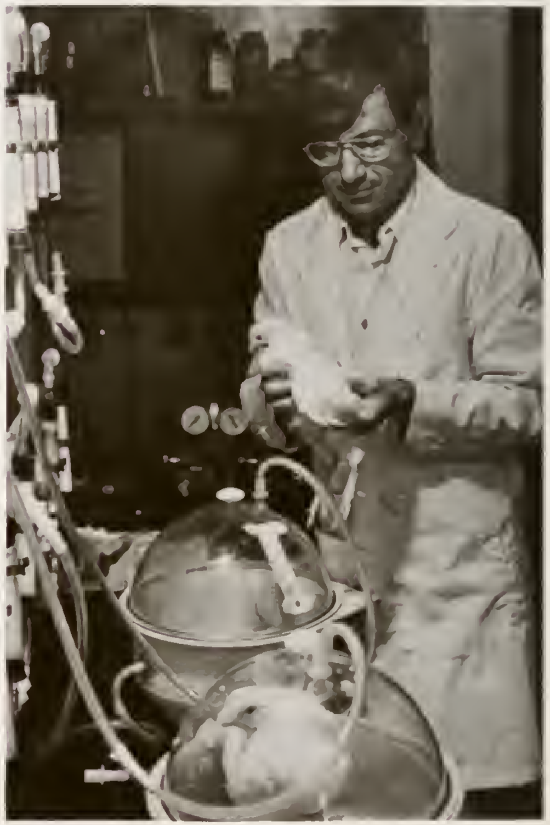
Researchers have determined that it is more critical to give chicks initial access to water than to feed, and recent studies have been conducted to determine the effect of starting day-old chicks on automatic waterers. Mortality is sometimes higher in pens using these automatic waterers rather than a more conventional method, because chicks crowd into the waterers and drown, or become wet and do not dry out. However, when a plastic collar is inserted in the automatic waterer, it can be used satisfactorily from day-old without any risk of higher chick mortality.

In an experiment designed to determine the effect of keeping birds under very confined conditions, researchers found a lower incidence of "scabby hip" when the birds had more floor space per bird. "Scabby hip" is a condition where the skin around the thigh becomes rough and frequently poorly feathered. There was a high incidence of "scabby hip" in the pens where the birds were only allowed ½ square foot per bird. When the birds were allowed as much as 1½ square feet per bird, the incidence was much lower. In one study, the incidence of "scabby hip" was higher in males than females.

For the past 30 years, geneticists have been selecting poultry on the basis of two economic traits: meat and egg production. Two types of poultry have been produced, broilers and layers, the former selected on the basis of rapid growth. Researchers have analyzed two traits to determine how the selection process has affected physiological traits in growing chicks: standard metabolic rate and body temperature. They have determined that broilers have a significantly lower standard metabolic rate than layer chicks (Leghorn). This supports the idea that broilers direct less energy toward maintenance metabolism and more energy toward true growth.

A second series of experiments compared body temperature and the development of body temperature regulation between the two types of chicks. Body temperature was determined from day of hatch to 8 weeks of age, the normal market age of broilers. Data showed that broilers have a lower body temperature and take approximately 6 days longer than layers to effectively regulate their body temperature.

The poultry industry can take advantage of these data by growing out broilers using low-temperature brooding. Chicks will maintain a lower body temperature and direct more energy toward true growth. It should be noted, however, that chicks must be carefully monitored during the first 3 weeks to make sure they are not uncomfortably cold and therefore stressed. In addition to more efficiently converting the energy in feed to high



Poultry research has determined that broilers direct less energy than layers toward maintenance metabolism and more energy toward true growth. These chicks are being placed in an environmental chamber by Dr. Wayne Kuenzel to determine their standard metabolic rate and body temperature.

quality protein within the body of chicks, low-temperature brooding will also tend to eliminate the problems of unabsorbed yolk sacs found in the abdominal cavities of some broilers at processing plants. The yolk sac contains yolk material that provides energy reserves for the chick for the first 4 days when it must learn to recognize and eat feed. A low-temperature brooding environment ensures that those reserves will be used.

Improved Utilization of Feed Resources

The Maryland dairy industry converts vast quantities of forages and feed grains into highly nutritious dairy products, and the improved efficiency of this conversion is of ongoing concern to both producers and agricultural researchers. Feed costs are major production costs; therefore, many options must be available to the dairy producer which will keep costs low enough to provide an affordable product to all consumers.

Although nutrient supplements frequently increase feed efficiency, very little work has been done to supplement the feed of dairy cattle with protein-supplying amino acids. These feed ingredients were thought to be destroyed in the first portion of the cow's stomach, where many proteins are broken down and reused in making microbial cells. New evidence now suggests that methionine or an analog of methionine may be useful in improving the amount of milk produced and the nutrient content of the milk.

The Maryland Agricultural Experiment Station is cooperating with other states in testing the effectiveness of an analog of methionine in improving the production of high-producing cows. The supplement was added at the rate of 2, 4 or 6 pounds per ton of concentrate and compared to a concentrate with no additive. There was an apparent response in milk and fat production at the 2- and 6-pound levels; however, all data must be evaluated before a general recommendation can be given on the usefulness of this supplement for dairy cows.

The efficiency of converting pounds of feed into pounds of product or gain is not of primary importance to the producers of horses in Maryland. The value of the production of these breeding establishments is very much influenced by rapid early growth of foals during their first year. Large yearlings are more valuable for race competition or recreation, and soundness in bone development is critical to their potential usefulness as adult horses. Therefore, the most efficient use of feed includes the best combination of nutrients to support desirable growth, in this case structurally sound bone growth.

A major concern of Maryland horse breeders is maintaining pregnancy throughout the gestation period. Dr. James McCall has been studying the effects of progesterone on mares with previous histories of abortion.

Researchers have fed calcium and phosphorus, the two basic minerals required for bone growth, to growing foals at two levels. One level included the standard recommendation for calcium and phosphorus in diets containing enough protein and energy to optimize growth of foals to 1 year of age. The second level was a diet with substantially higher levels of calcium and phosphorus. The progress of bone development for foals fed the two levels of minerals was monitored by making radiographic (x-ray) observations of the cannon bones and specific joints. The results of this research will be used to assess current recommendations for calcium and phosphorus levels in foal diets.

Environmental Quality

Suspected water pollution from nonpoint sources raises the question of the extent to which grazing livestock contribute to the level of nutrients and bacteria in water adjacent to the grazing lands. No specific answers are available for Maryland, however, experiments have been designed to compare runoff water from land grazed by cattle and swine, and water from a wooded area that is a typical central Maryland wildlife habitat. The information will be used to determine whether or not livestock operations have an impact on pollution, and to develop management systems to minimize this impact.

New Frontiers

Agricultural researchers recognize that some basic biological processes are essential to efficient animal production, and that better understanding of these processes will be needed to deal with present and future problems. For example, research in milk synthesis can solve future nutrition problems of young animals, not only in the dairy industry, but also in the production of beef cattle, horses, sheep and swine.

Despite the economic importance of milk production, the biochemical and physiological processes involved in the secretion of milk are still imperfectly understood. Experiment Station research is aimed at developing methods of isolating plasma membrane from the secretory cells of the bovine mammary gland. This membrane is actively involved in the uptake and transport of milk precursors into the cell, and in the process of milk secretion.

Milk production research is relevant to breast cancer, since the cell surface is a major site for change when normal cells are transformed into cancer cells. When cells lose their surface "stickiness", they begin an uncontrolled growth, and invade other tissues in the body. Isolating the surface membrane of mammary cells is therefore an important first step in understanding this phenomenon at the cellular level. Preliminary data have been obtained on the nature and composition of this membrane and have provided material for further study.

Mastitis, another major disease of the mammary gland, is caused by the invasion of bacteria through the teat and into the ducts where milk is normally stored. Losses in milk production due to bacterial mastitis exceed $1 billion per year in the United States alone. The Maryland Agricultural Experiment Station is attempting to devise methods of increasing the resistance of cows to mastitis. As part of this research, new ways of immunizing cattle against the common mastitis pathogens are being developed, and the basic defense mechanisms of the gland to bacterial infection are being studied at the cellular level.

Poisoning by heavy metals, such as lead and mercury, affects protein use in the body and is a constant hazard to man and animals alike. However, researchers have determined that dietary iron modifies these reactions. Current studies will provide a much better understanding of the interaction between iron, lead and protein in the animal body, and will develop ways of dealing with accidental lead contamination in the future.

Current methods of controlling internal parasites in animals usually rely on a chemical that is selectively more toxic to the parasite than the host. Treatment kills or weakens the parasite with little damage to the host, and usually has a minor impact on the performance of farm animals. In one current study of parasite control, the level of chromium present is analyzed by a radioisotope method to determine parasite damage, a factor which is usually difficult to measure. This chromium technique actually monitors the level of blood cell destruction by blood-sucking parasites and provides a more precise measure of their activity.

The influence of parasite load on vitamin requirements of animals is also being investigated, along with the potential for controlling parasites through selective imposition of vitamin deficiencies. An essentially germ-free environment must be used for this work because bacteria can contribute to the production of vitamins in the digestive tract. The results of this research can be transferrable to control procedures for similar parasites in farm animals.

The formation of milk protein is the most efficient conversion of low quality feeds to a high quality product for human consumption, and basic research in this area can contribute to future improvements on this efficient system. One Experiment Station project is concerned with studying the molecular mechanisms involved in the attachment of sugars to the kappa fraction, or K-casein.

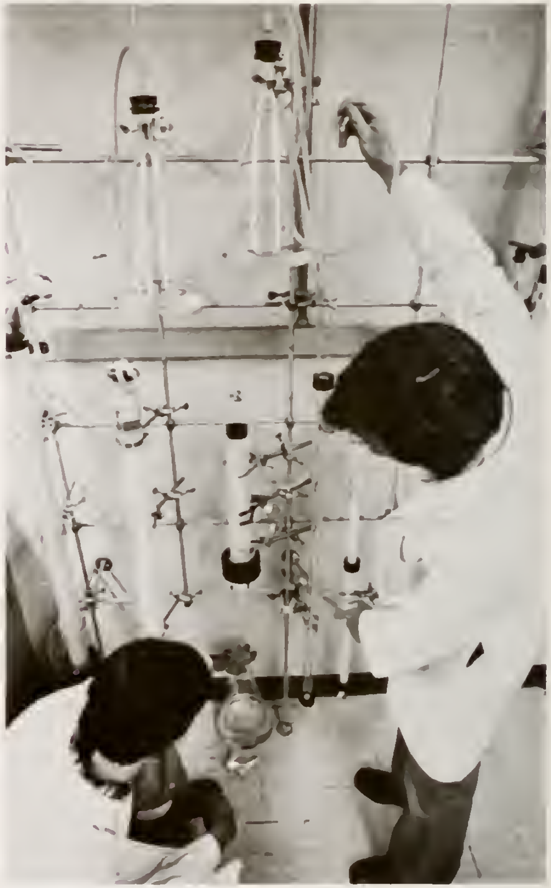
The casein family of proteins comprises nearly 75 percent of the total protein secreted into cow's milk. These proteins are highly insoluble and can be readily precipitated under a variety of physical-chemical conditions, including the presence of calcium. Milk is a rich source of calcium, and provides an optimal environment for caseins to precipitate.

Among caseins, the K-casein is a protein that has a number of sugars attached to its backbone at a specific point. Because of the solubilizing effect of the sugars, the kappa fraction holds all the other caseins together as very finely suspended micelles or colloidal aggregates and prevents protein precipitation. This phenomenon also gives the characteristic white color to milk.

During the digestive process, whether in the stomach or in commercial cheesemaking operations, the enzyme rennet clips the kappa protein at a certain weak spot in its backbone. As a result, the portion of the protein that has the sugars attached to it is released. This causes precipitation or coagulation of the rest of the caseins and the milk. In human nutrition, this phenomenon arrests the components of milk for slow and steady digestive processes and helps assimilate the nutrients of milk into the human body. In commercial cheesemaking, the process provides a starting point for the characteristic texture of the finished product.

Over the years, classical genetics has served an extremely useful purpose in selecting cows with high potential for milk production. However, further improvement in this area can be considerably augmented if fundamental knowledge about the synthesis of milk proteins and their stabilization can be explored more thoroughly. Future breeding programs can then be directed to specifically select animals for high milk protein, and therefore total milk production.

Work on this project so far has shown that the mammary tissue from the lactating cow possesses a synthesizing machinery that involves an interplay of fat, sugar and protein components of the cell. This machinery effects a transfer of sugars to certain proteins, making them glycoproteins (i.e., sugar-bearing protein). Since the milk-secreting tissue synthesizes a variety of glycoproteins, efforts so far have been directed at establishing the details of the synthetic machinery. After all the parameters have been fully worked out, questions can be directed toward systematically resolving the mechanism of sugar attachment to the protein backbone of kappa casein.



Milk is the most efficient conversion of low quality feeds to a high quality product. K-casein, which makes milk white, is being studied as an important factor in the assimilation of milk nutrients into the human body.

Crop Production

John H. Hoyert

Crop production occupies a very important part of the economy of Maryland, adding over $283 million to the agricultural income of the state in 1977. This value of crops is expected to increase in 1978, with more than 17,000 farms sharing in this production income.

Genetics, plant breeding and evaluation play major roles in the research efforts of the Maryland Agricultural Experiment Station. Close cooperation is also maintained with other states, the U. S. Department of Agriculture and commercial businesses with private breeding programs. This cooperation has resulted in the release of many new varieties for more efficient production.

New Varieties Improve Crop Production

Maryland wheat growers have shown an intense interest in the recently released Potomac variety because of its excellent yield potential and disease resistance. Limited seed availability has held down plantings of this new variety, but striking increases in acreage are expected with increased seed supplies. Three promising breeding lines of wheat are currently undergoing seed increases for possible release. These lines are characterized by one or more features of disease resistance, early maturity, good test weight, standability and increased yield.

Fungal diseases of barley have severely damaged crops in many locations on the Eastern Shore. Fortunately, there are promising breeding lines in the Experiment Station research program that carry resistance to two of these diseases; seed from three of these breeding lines is being increased for possible release.

Research in variety development of processing tomatoes, fresh market tomatoes and home garden tomatoes is a long-term effort. The major objectives include adaptability for mechanical harvesting and handling, improved processing qualities and high yields of quality fruit. Several promising breeding lines will be tested throughout the eastern United States before being considered for possible release to growers. Similarly, the goal of the sweet potato breeding program is the development of varieties with high yields, good storage and processing characteristics and disease and nematode resistance. Presently three lines with high yield potentials are being closely studied for processing and storage qualities.

Potomac wheat, a recently released variety, is being examined by Dr. David Sammons for disease resistance. This variety is noted for its excellent yield potential.

Cultivars of Kentucky bluegrass, the major turfgrass species in Maryland, are being evaluated for quality and disease and insect resistance. Among the 70 breeding lines being tested to provide recommendations for homeowners and turfgrass growers, the following received top ratings: A-34, Adelphi, Brunswick, Enmundi, EVB-391, K1-155, K1-157, Monopoly, P-59 Parade, Plush, PSV 190 Vantage and Victa. Lines which were rated slightly lower but provided good turf cover were BA 61-91, Baron, Cheri, Fylking, K1-158 Majestic, P-154 PSV 150, PSV-197, Sydsport and Touchdown.

Work continues on the development of multiple disease resistant Maryland tobacco with improved quality and yield. As a result of the outstanding success of this Experiment Station program, tobacco growers have realized significantly increased revenues in recent years. In 1978, 95 percent of the varieties used in Maryland had been released by the Maryland Agricultural Experiment Station in the 12 years since seed of new releases became available.

Soybean acreage has increased over 60 percent in the past 10 years, from 214,000 to 345,000 acres. This growth in farmer interest in soybeans, backed

Genetics has played an important role in increasing soybean yields over 60 percent in the past 10 years. Dr. William Kenworthy tags a test variety being evaluated for yield ability and seed quality.

by an active program in soybean breeding and evaluation, led to the release of two new soybean varieties in 1978. Miles, a new medium-maturing variety developed by the Experiment Station soybean breeding program, exhibits superior yielding ability and improved seed quality when compared to Kent and Delmar, the varieties it would replace.

Bay is a new full-season variety developed by the Virginia Agricultural Experiment Station, and released in cooperation with the Maryland Agricultural Experiment Station. Bay, which matures approximately 4 days later than Essex, has yields similar to Essex but higher than York, the two most widely grown varieties in Maryland. Varieties are also being developed with increased protein content, resistance to insect pests and adaptability to double-cropping systems.

Crop Management Research Increases Efficiency

Maryland Agricultural Experiment Station scientists have placed a major emphasis on management research aimed at improving the efficiency of crop production. Increased demands for more livestock products and more intensive forage production systems have resulted in forage production on lands too steep for intensive cropping systems. Minimum-tillage forage establishment or sod seeding is a practice that can lower production costs as well as reduce soil erosion, resulting in less environmental pollution.

Experiment Station research has indicated that red clover is the most easily established legume in the sod-seeding method; sod seeding alfalfa into old hay fields or pasture sods has been much less successful. However, when alfalfa is sod-seeded into small grain stubble in late summer, weed problems and erosion hazards are greatly reduced.

Birdsfoot trefoil, ladino clover and crownvetch are between red clover and alfalfa in ease of establishment using sod-seeding techniques. These species differences can be used to advantage, however, by seeding alternate rows of red clover and trefoil, ladino clover and crownvetch. With this system the need for sod-seeding pasture renovation can be extended beyond the normal 2-to 3-year life of most red clover stands. Land sod seeded with alternate rows of red clover and white clover or crownvetch produced daily beef animal gains and total live weight gains per acre that were nearly twice those from similar pastures without sod-seeded legumes.

Harvest studies with alfalfa have shown that early harvest in the spring will insure higher quality forage; however, a 30-day interval between harvests will usually result in lower yields and shorter stand life. An average of 35 days between harvests appears about right for better yields and longer stands. Higher fertility levels will produce larger hay yields and stands that will remain productive over more years.

In the past, honeydews have not been successful in Maryland's humid climate and were better adapted to dry, irrigated areas with longer growing seasons. However, a new honeydew cultivar, Tam-Dew, shows considerable promise for the Maryland area. Tam-Dew is about 3 weeks earlier than the western honeydew and has excellent quality; the variety shows considerable tolerance to troublesome melon diseases including alternaria leaf spot, fusarium wilt and powdery mildew. Tam-Dew may be stored for several weeks with refrigeration and a week or so without refrigeration. Time of harvest is critical, and ethylene treatment of Tam-Dew melons appears necessary for controlled ripening and orderly marketing.

An experimental high density planting of four standard apple cultivars, Delicious, Golden Delicious, Cortland and Stayman, has produced its third consecutive crop on the dwarfing rootstock Malling 26, exhibiting a range of fruiting potential. High density, with trees 2 to 4 feet apart in the row, has consistently outproduced other systems: Delicious yielded 471 bushels per acre, Cortland 554 bushels, Stayman 760 bushels and Golden Delicious 1,156 bushels. The increased yields of Golden Delicious and Stayman with high density plantings are especially significant when compared with the normal 300 to 400 bushels per acre produced in standard orchards.

Researchers are investigating the chemical thinning of apples with low volume air-blast applications on the hard-to-thin spur type Delicious cultivars. The insecticide 1-naphthyl-N-methyl carbamate (carbaryl) has proved to be the most effective chemical on spur type Delicious.

High density apple plantings have consistently out-produced other systems, and, as Ennis Dodd shows, can be harvested from the ground.

The Magness pear was planted in Maryland orchards 15 years ago because of its exceptional fruit quality and good resistance to fire blight, the bacterial disease which historically has kept the east out of the pear business. However, Magness pollen is sterile, and fruit set has been a difficult problem. In recent Experiment Station research, soluble boron was incorporated with the growth regulator 2,4,5-trichlorophenoxy propionic acid (2,4,5,Tp), and indications are that this may produce adequate fruit set and fruit size. Research will be continued to determine if this combination provides the answer to the problem of fruit set in the Magness pear.

Tobacco and Health Studies Show Progress

Recent studies by some public health agencies have suggested that high alkaloid and tar levels in cigarettes may be contributing to health problems in heavy smokers. In response, major progress has been made in reducing the alkaloid levels in Maryland tobacco through breeding. Genetic material from a low alkaloid burley tobacco was introduced into the Maryland 609 variety, and selections were made from 1975 to 1978 for plants with typical characteristics of Maryland tobacco, but with lower alkaloid levels. Plants averaging 0.60 percent alkaloids were selected in 1978 for further development. This compares to an average of 1.90 percent for the Maryland 609 parent in 1978, and indicates a significant advancement over the 3 years. The ultimate goal is to release a commercially accepted variety with total alkaloid levels of one-third to one-half the levels found in current varieties.

Mechanization Reduces Labor and Drudgery

Experiment Station agricultural engineers are developing methods for curing primed Maryland tobacco, and evaluating an automatic harvester from the flue-cured tobacco area. Success in mechanizing tobacco must come from reducing the labor required in harvesting and stripping operations, since these operations account for over 70 percent of the total labor requirement. Progress has been encouraging. The mechanical harvester resulted in a leaf loss of 8 to 10 percent. This loss would be acceptable to growers; however, leaf breakage and bruising by the harvester need to be reduced. In addition, curing schedules for primed Maryland tobacco have been developed that give a cured leaf acceptable in appearance, but in need of improvement in smoking qualities. The combination of these curing methods and the mechanical harvester show a potential for reducing harvesting and stripping labor requirements from approximately 180 man-hours per acre to around 60 man-hours per acre. Just as importantly, all the heavy handlifting operations of conventional harvesting will be removed.

Pesticide Research Features Improved Control

Insect and nematode problems have become more complicated in recent years, and the Maryland Agricultural Experiment Station has developed continuing programs of pesticide research on most of the commercial crops in Maryland.

In one research program, synthetic pyrethroids produced by three different chemical companies were evaluated, and were shown to be effective against a large number of vegetable insect pests, including corn earworm, Colorado potato beetle, cabbage looper and imported cabbageworm. These compounds have the advantage of being relatively safe, and effective at extremely low rates. Excellent insect control has been achieved at rates varying from 0.01 to 0.2 pounds active ingredient per acre. Presently, most insecticides are used at 0.5 to 2 pounds active ingredient per acre.

Other compounds which performed exceptionally well against a wide variety of vegetable insect pests were Orthene and Dacamox. Both compounds are systemic in nature, that is, they are translocated within the plant. Orthene is particularly effective against aphids and moth and butterfly larvae, and Dacamox is effective against Mexican bean beetles, Colorado potato beetles and spider mites. Studies on the control of whiteflies on greenhouse tomatoes has shown Temik to be very effective. A 2-year residue study has been completed, and this compound should soon be labeled for use in the greenhouse.

Experiment Station researchers have developed a program of pesticide research on commercial crops. The results will enable growers to control pests more effectively with significantly lower rates of insecticide use.

The tobacco budworm often causes serious losses to tobacco in Maryland, and growers have found this pest to be most difficult to control. Experimentation has shown at least three steps to good budworm control: the first step is to determine if the pest is causing enough loss to make control measures advisable. A technique is being developed to enable a grower to quickly and accurately determine how much damage is being done.

The second step is to predict the dollar loss caused by the budworm. A good, accurate decisionmaking scheme is now being developed by Experiment Station researchers to determine the feasibility of applying an insecticide. The third step to successful insect control is to determine the proper use of an effective chemical. The Maryland Agricultural Experiment Station conducts continuing evaluation programs of new chemicals for budworm control to improve the present insecticides.

Strawberries are an important crop in selected areas of Maryland. The two nematodes of importance on strawberry plants are the northern root-knot nematode and the lesion nematode. Recently, the primary nematicide used in Maryland to produce nematode-free strawberry plants, dibromochloropropane (DBCP), has been threatened with cancellation of this registered use. However, researchers have tested the nematicides Temik, Nemacur and Furadan for efficiency in controlling nematodes and phytotoxicity in strawberry plants. Results show that preplant soil application of either Temik or Nemacur provides almost complete control, while Furadan and DBCP are less effective. None of these chemicals is phytotoxic at nematicidal levels.

Plants of 33 strawberry cultivars were grown in soil infested with northern root-knot nematode to determine susceptibility. While no cultivar was immune to this nematode, Redglo, Florida Ninety, Delite and Raritan were relatively resistant. Earliglo, Darrow, Apollo, Sparkle and Sunrise were quite susceptible.

The management of pests on soybeans depends on appropriate decisionmaking models for use in an on-going pest management program, plus development of efficient control recommendations. A field sample of Mexican bean beetles now will tell not only how many beetles are present, but also the potential for damage. The anticipated level of defoliation can be predicted, and the need for control measures determined.

One problem with using chemicals to control Mexican bean beetles is that pesticides kill both pests and beneficial insects. However, when the predicted level of defoliation of soybeans exceeds an economic level, pesticide use is necessary. Current studies are testing the effectiveness of Dimilin, a chitinase inhibitor, in controlling Mexican bean beetle. Dimilin has the potential for controlling the beetle larvae with minimal effect on parasitic wasps which attack the beetle larvae.

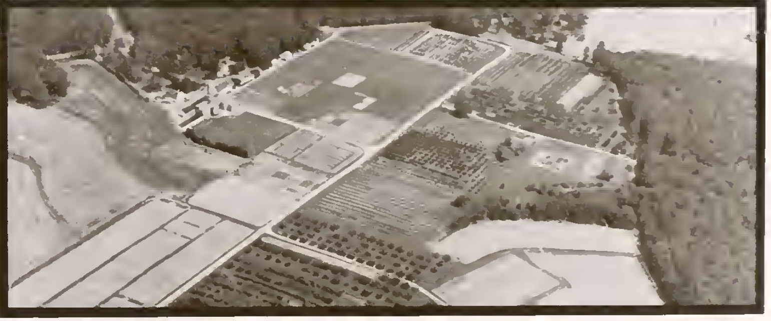
Air Pollution Affects Crop Growth and Productivity

Air pollution damage to crops grown in Maryland continues to increase with increased urbanization. Information on the impact of air pollution on plant productivity and the association of symptom development with productivity is limited.

In one Experiment Station research program, cultivars of soybeans, wheat and tobacco were grown under normal conditions in the field, then exposed to controlled levels of air pollutants. All three species exhibited some damage from the introduced air pollutants. Surprisingly, young tobacco plants grown in normal air exhibited no symptoms of pollution damage, but growth rates averaged approximately 23 percent less than plants grown in air filtered to remove air pollutants. The significance of this research could be far-reaching, especially if further studies with other crops determine that this unexpected "hidden" damage is extensive.

Dr. Charles Mulchi checks the temperature inside an environmental chamber designed to study the effects of air pollution on soybeans, wheat and tobacco. This "hidden damage" could be economically significant.

Projects and Publications
1977-78



The Maryland Agricultural Experiment Station was established to develop, conduct and disseminate research information. The research projects, based on recommendations from farm organizations, the Cooperative Extension Service, or the scientists' knowledge of research needs, are funded by state funds, through the Maryland state legislature, and federal funds, through the Cooperative State Research Service. In addition, Experiment Station scientists collaborate with scientists and engineers of the U.S. Department of Agriculture.

This knowledge is communicated to the agricultural community through Experiment Station miscellaneous publications and bulletins. Miscellaneous publications reflect research findings with a relatively short reference value; bulletins deal with basic data which will be added to with time, and have a longer reference value.

Experiment Station scientists frequently submit scientific articles to various professional journals. These articles reflect the Maryland Agricultural Experiment Station's reputation for research excellence.

The following section lists projects, publications and scientific articles for 1977-78.

Miscellaneous publications and bulletins will be mailed free to all residents of the state who request them. Please address all requests to:

Agricultural Duplicating Services
4910 Calvert Road
College Park, MD 20742

AGRICULTURAL AND EXTENSION EDUCATION

Projects

T-22	Recreational Carrying Capacity of State Forests in Maryland's Western Region. J. W. Longest, F. R. Kuss.
T-23	Community Structure and Quality of Life: Measurement and Analysis. J. W. Longest, M. A. Konan.
T-25	Impact of In and Out Migration and Population Redistribution in the Northeast. J. W. Longest, M. A. Konan, D. L. Tweed.
T-26	Behavioral Assessment of Crowding and Environmental Deterioration in Outdoor Recreation Settings. J. W. Longest, F. R. Kuss.

Scientific Articles

A2391	FFA Leaders: Personality and Leadership Style. J. A. Owings, C. L. Nelson. Paper presented at the National AATEA Convention in Atlantic City, December 2, 1977.
A2420	Social Carrying Capacity and User Satisfaction: An Experiential Function. R. H. Becker. *Leisure Sciences.*
A2477	A Paradigm for Assessment of Community Services Delivery Systems. E. H. Owen, J. W. Longest, D. L. Tweed. Presented at Rural Sociology Meetings, September 1978.
A2478	Poverty and the Distribution of Mental Health Resources: Rural-Urban Comparisons. M. A. Konan, D. L. Tweed, J. W. Longest.
A2484	Contact-Preference Norms Versus Actual Contacts: Crowding Among Brule River Canoers. J. J. Vaske. *Social Psychology.*
A2493	Apostle Island National Lakeshore Visitors: Their Characteristics, Use Patterns and Perceptions. T. A. Heberlein, J. J. Vaske. University of Wisconsin Technical Report.

Miscellaneous Publications

920	Distribution of Mental Health Manpower in Facilities in the United States with Rural-Urban Comparisons. D. L. Tweed, M. A. Konan, J. W. Longest.
928	Job Satisfaction of Workers in a Broiler Processing Plant. J. W. Goble, C. L. Nelson.
933	An Analysis of Selected Attitudes of Rural People in Ghana Involved in the Food for Work Program. G. C. Whaples, T. O. Ogunfiditimi.
938	Social Change and Development in Metropolitan, Suburban, Urban and Rural Counties: Maryland and the Northeast. M. A. Konan.
939	Use of Recreational and Cultural Facilities in Frederick County, Maryland. C. Larsen, M. A. Konan.

AGRICULTURAL AND RESOURCE ECONOMICS

Projects

A-18-AU	Dairy Adjustments and Supply Response in Maryland and the Northeast. J. W. Wysong.
A-18-BB	Maryland Farm and Open Country Real Estate Transfers. S. Ishee.
A-18-BG	Analysis of Costs and Returns to the Breeder-Owned Sectors of the Maryland Horse Industry. R. G. Lawrence.
A-18-BJ	Economic and Environmental Feasibility of New Pulp and Paper Mills in the Northeast. I. W. Hardie, G. E. Coene.
A-18-BK	Evaluation of Incentives for Increasing Productivity on Nonindustrial Forest Tracts in Maryland. S. Ishee.
A-18-DA	Optimum Economic Management Plans for Loblolly Pine Plantations in the Mid-Atlantic United States. I. W. Hardie.
A-18-DB	Contrasting Energy Transformation in Grain Production. P. W. Foster.
A-19-AC	Comparative Impact of Current and Alternative Systems of Taxation on Farms and Counties. S. Ishee.
A-19-AE	Economic Development Zone: A Strategy for Balanced Rural Growth and Development. A. Matteucci.
A-19-AI	Public Outdoor Recreation as a Component for Rural Development in the Appalachian Region of Maryland. I. W. Hardie, I. E. Strand.
A-19-AJ	An Economic Analysis of Agricultural Employment, Unemployment and Productive Changes in Maryland, the Northeast and the United States. J. W. Wysong.
A-19-AK	Optimum Farm Organization for Limited Resource Farmers. D. F. Tuthill, R. Douglass.
A-19-AL	Land Use, Taxes, and Service Impacts of Columbia, Maryland on Howard County. W. J. Bellows.
A-26-CE	Economic Analysis of the Maryland Horse Industry. R. G. Lawrence.
A-26-CI	Effects of Alternative Pricing Structures and Pooling Methods on the Dairy Industry in the Northeast. A. M. Prindle.
A-26-CL	Economic Limitations to Feeding the World's Growing Population. J. R. Moore.
A-26-CM	Economics of Commercial Sod Production in Maryland. B. V. Lessley.
A-26-CN	Supply, Pricing, and Marketing Alternatives for Cattle, Beef Systems in the South. J. E. Via.
A-26-CO	Implications of Demand, Structure and Energy Changes for the Northeast Broiler and Egg Industries. F. E. Bender.
A-26-CP	Economic Factors Affecting Northeast Markets for Local Fruits and Vegetables. J. L. Cain.

Scientific Articles

A2431	On the Measurement of Economic Benefits for Potential Public Goods. I. W. Hardie, I. E. Strand. *American Journal of Agricultural Economics.*
A2480	The Maryland Sod Industry. B. V. Lessley, J. T. Gilbert. *Weeds, Trees and Turf Magazine.*
A2485	Measurement of Economic Benefits for Potential Public Goods. I. W. Hardie, I. E. Strand. Paper presented at American Agricultural Economics Association.
A2491	Costs-Returns for Sod Production in Maryland. B. V. Lessley, J. T. Gilbert. *Weeds, Trees and Turf Magazine.*

A2497	An Analysis of Surf Clam Production Using an Exhaustible Resource Model. R. S. Cessine, I. E. Strand. *The Journal of the Northeastern Agricultural Economics Council.*
A2498	Meeting the Demands for New Degree Programs and Course Offerings: The Experience at Maryland. I. E. Strand, F. E. Bender. *The Journal of the Northeastern Agricultural Economics Council.*
A2508	Cost-Returns for Harvesting and Transporting Turfgrass. J. T. Gilbert, B. V. Lessley. *Weeds, Trees and Turf Magazine.*

Miscellaneous Publications

925	The Surf Clam as a Nonrenewable Resource. R. S. Cessine, I. E. Strand.
926	The Economic Potential for Expanding India's Grain Production. R. D. Nunez, J. R. Moore.
927	Market Analysis of Maryland's Horse Industry. R. G. Lawrence, W. R. Jones, F. E. Bender.
935	A Simulative Approach to Controlling Mexican Bean Beetle on Soybeans in Maryland. K. H. Reichelderfer, F. E. Bender.
937	Maryland Consumers View Fresh Tomato Marketing. J. L. Cain, R. W. Lines.

AGRICULTURAL ENGINEERING

Projects

R-21	Development and Construction of Specialized Facilities and Equipment for Use in Agricultural Research. K. E. Felton.
R-50	Labor Performance While Wearing a Respirator. A. T. Johnson, L. Santa-Maria.
R-53	Shear Properties of Frozen Fish Fillet Blocks. F. W. Wheaton.
R-57	Mathematical Model of Oyster Population in the Chesapeake Bay. F. W. Wheaton, A. Cabraal.
R-58	Water Quality Maintenance in Closed Cycle Fish Culture Systems. F. W. Wheaton, T. B. Lawson.
RD-52	Water Quality Changes in Oyster Processing. F. W. Wheaton, A. L. Ingling.
RM-2	Physiological Responses of Chickens to Varying Environments. L. E. Carr, O. P. Thomas.
RO-55	Curing Primed Maryland Tobacco. B. C. Frey, J. H. Hoyert.
RAM-49	Feasibility of Utilizing Solar Energy in Commercial Broiler Production. K. E. Felton, J. L. Cain, O. P. Thomas, R. B. Brinsfield, L. E. Carr.
ROCG-54	Assessment of Nonpoint Source Loadings from Selected Agricultural Activities. J. E. Ayars, J. H. Axley, R. F. Davis, D. C. Wolf.
RAKO-51	Spray Irrigation of Domestic Waste Sewage Effluent to Forested Atlantic Coastal Plain Soils. J. H. Axley, J. C. Stevenson, J. E. Ayars.

Scientific Articles

A2365	Applications of a Maryland Version of USDAHL-74 to a Watershed in Prince George's County, Maryland. H. N. Holtan, J. P. Ormsby, G. T. Fisher. Paper presented at Smithsonian Institution Workshop "Watershed Research in Eastern North America".
A2372	USDAHL-74 Model as a Planning Tool. G. T. Fisher, J. E. Ayars, D. L. Nelson, H. N. Holtan. Paper presented at American Society of Agricultural Engineers meeting, June 1977
A2389	Broiler Response to Three Ventilation Rates. L. E. Carr. Paper presented at American Society of Agricultural Engineers meeting, December 1977
A2390	Utilization of Solar Energy in Broiler Production. R. B. Brinsfield, K. E. Felton. Paper presented at the winter meeting, American Society of Agricultural Engineers, 1978.
A2392	A New System for Residential Wastewater Disposal. J. E. Ayars, H. L. Brodie, H. N. Holtan. *Proceedings of the Third World Congress on Water Resources.*
A2421	To Mark Sampling Events on a Runoff Hydrograph. A. T. Johnson, R. Kort, J. E. Ayars. *Agricultural Engineering Journal*
A2426	Exhalation Waveshape During Rest and Exercise. A. T. Johnson, V. C. Thomas. *Annals of Biomedical Engineering.*
A2467	Production Function for the Maryland Oyster Fishery. R. A. Cabraal, F. W. Wheaton. *Transactions of the American Society of Agricultural Engineers*
A2476	Identification of Suitland Bog Recharge Area. J. E. Ayars. Report to the Maryland-National Capital Park and Planning Commission.
A2489	A New Concept for Residential Wastewater Disposal. J. E. Ayars, H. L. Brodie, H. N. Holtan. Paper presented at North Atlantic Region American Society of Agricultural Engineers meeting, August 1978.
A2490	Bacterial Growth Rate in Soft-Shell Clam Shellstock During Storage at Selected Temperatures. F. W. Wheaton, G. U. Schaffer, A. L. Ingling, L. W. Douglass. Proceedings of the National Shellfish Association.
A2511	Heat Transfer Study of the WBGT and Botsball Sensors. A. T. Johnson, G. D. Kirk. *American Industrial Hygiene Association Journal*

Miscellaneous Publications

918	University of Maryland Version of USDAHL Model of Watershed Hydrology. H. N. Holtan, M. Yaramanoglu.
929	Conversions and Units in Nonpoint Source Pollution. G. T. Fisher.

AGRONOMY

Projects

B-43	Soybean Varietal Improvement. W. J. Kenworthy.
B-77	Forage Crop Variety Evaluation. N. A. Clark.
B-79	Use of Herbicides to Control Weeds in Forages. J. V. Parochetti.
B-95	Control of Johnsongrass from Seed and Rhizomes. G. W. Burt, J. V. Parochetti.
B-99	Factors Related to Irrigation of Tobacco. C. L. Mulchi, C. G. McKee, J. H. Hoyert.
B-103	Tobacco Breeding, Testing and Quality Evaluations of Maryland Tobacco. M. K. Aycock, J. H. Hoyert, C. L. Mulchi.

B-109	Breeding and Evaluation of Kentucky Bluegrass and Associated Species for Turf. C. A. Darrah, D. J. Wehner.
B-116	Varietal Improvement in Wheat and Barley. J. W. Johnson.
B-117	Biological Activity and Mode of Action of Herbicides Used on Corn, Soybeans and Tobacco. J. V. Parochetti, G. W. Burt.
B-118	Agronomic Feasibility of Direct-Seeding of Field Tobacco. J. H. Hoyert.
B-119	Forage Production and Quality Evaluations. A. M. Decker, D. J. Undersander, R. F. Dudley.
B-121	Principles of Dissipation and Movement of Triazine and Other Herbicides. G. W. Burt, J. V. Parochetti.
B-122	Physiological Relationships of Tobacco to Environmental, Cultural and Genetic Factors. C. L. Mulchi, J. H. Hoyert, M. K. Aycock.
B-123	Response of Alfalfa to Fertility, Irrigation and Cutting Management. N. A. Clark.
B-126	Control of Mexican Bean Beetle in Soybeans Through Resistant Varieties. W. J. Kenworthy.
B-127	Reducing the Influence of Air Pollution on Plant Productivity in the Northeast. C. L. Mulchi, M. K. Aycock, W. J. Kenworthy.
BG-1	Beef and Dairy Replacement Production on Pasture. A. M. Decker, N. A. Clark, J. H. Vandersall.
BO-2	Effect of Municipal Sludge on Growth and Elemental Composition of Two Tree Species. J. E. Foss, D. C. Wolf.
BO-3	Evaluation of an Undisturbed Deciduous Ecosystem as a Source of Nonpoint Pollution. D. C. Wolf, J. E. Ayars, J. F. Kundt.
O-48	Soil Characterization Studies Relating to Their Genesis, Classification and Utilization. J. E. Foss, D. S. Fanning, J. R. Miller.
O-57	Origin, Transformation and Management of Nitrogen in Soils, Waters and Plants. J. H. Axley, J. Legg, F. Abbruscato.
O-81	Residual Effect of Thirteen Cropping Systems on Corn and Soybean Yields and Soil Aggregation. E. Strickling.
O-82	Soil Testing for Environmental Control. J. H. Axley, P. A. Snow, V. Pavanasasivam.
O-84	Investigation of Heavy Metals in Sewage Sludge-Soil-Plant Systems. D. S. Fanning, J. E. Foss.
O-85	Microbiology of Sewage Sludge Amended Soils. D. C. Wolf.
O-86	Soil Properties Affecting Sorption of Heavy Metals from Wastes. D. S. Fanning.
O-87	Identifying and Preventing Sulfur Related Problems in Soils Created in Coal Mining Operations. D. S. Fanning.
O-88	Forage-Livestock Systems for Land with Soil and Site Limitations. A. M. Decker.

Scientific Articles

A2383	The Influence of Initial Soil Moisture on Subsequent Rapid Leeching of Herbicides. G. W. Burt. *Northeastern Weed Science Society Proceedings*
A2387	Effect of No-tillage Cover Crops by Paraquat, Diquat, or Glyphosate Applied in Water or Fertilizer Solutions. J. V. Parochetti. *Northeastern Weed Science Society Proceedings*
A2402	A Hand-Held Grafting Device for Making Uniform Wedge Cuts. M. C. White. *Agronomy Journal*
A2403	Differential Cultivar Tolerance in Soybean (Glycine Max L.) to Phytotoxic Levels in Zn in a Sassafras Sandy Loam. II. Range of Soil Zn Additions and the Uptake and Translocation of Zn, Mn, Fe, and P. M. C. White, R. L. Chaney, A. M. Decker. *Agronomy Journal*
A2404	Role of Roots and Shoots of Soybean (Glycine Max L.) in Tolerance to Excess Soil Zinc. M.C. White, R. L. Chaney, A. M. Decker. *Crop Science*
A2405	Soil Temperature and Sewage Sludge Application Effects on Corn (Zea mays L.) I. Grain and Stover Yields and Ear Leaf Macronutrient Content. C. C. Sheaffer, A. M. Decker, R. L. Chaney, L. W. Douglass. *Agronomy Journal*
A2407	Nitrogen Rate and Low Plant Population Studies with Maryland Tobacco. C. G. McKee. *Tobacco Science*
A2409	Differential Cultivar Tolerance in Soybean (Glycine Max L.) to Phytotoxic Levels of Zn in a Sassafras Sandy Loam. I. Range of Cultivar Response. M. C. White, A. M. Decker, R. L. Chaney. *Agronomy Journal*
A2412	The Effects of Erysiphe Graminis on Near-Isogenic Lines of Chancellor Wheat. I. Agronomic Characteristics. J. W. Johnson, P. S. Baenzinger, R. T. Smith. *Crop Science*
A2422	Survival of Indicator Bacteria in Sewage Sludge Amended Soils. G. C. Stanton, D. C. Wolf, L. W. Douglass. *Journal of Environmental Quality*
A2429	Soil Temperature and Sewage Sludge Application Effects on Corn (Zea mays L.) II. Soil Organic Matter, DIPA-TEA Extractable Heavy Metals and Corn Metal. C. C. Sheaffer, A. M. Decker, R. L. Chaney, L. W. Douglass. *Agronomy Journal*
A2430	Effect of Dairy Manure and Sewage on 14 C-Pesticide Degradation in Soil. R. C. Doyle, D. D. Kaufman, G. W. Burt. *Journal of Agricultural and Food Chemistry*
A2440	Adherence of Spray-Applied Liquid Digested Sewage Sludge to Tall Fescue. R. L. Chaney, C. A. Lloyd. *Journal of Environmental Quality*
A2446	Effects of Erysiphe Graminis on Near-Isogenic Lines of Chancellor Wheat. II. Quality Characteristics. J. W. Johnson, P. S. Baenziger, W. T. Jamazaki, R. T. Smith. *Crop Science*
A2452	Effect of Montmorillonite and Trace Elements on the Growth of *Penicillium Frequentans*. R. W. McCormick, D. C. Wolf. *Soil Science Society American Journal*
A2479	Soil-Landscape Relationshps of the Tidal Marshes of Maryland. R. G. Darmody, J. E. Foss. *Soil Science Society American Journal*
A2488	EPTC Plus R-25788 Injury to Corn as Affected by Plant Age at Treatment. G. W. Burt, C. A. Buzio. *Weed Science*
A2510	Yield and Agronomic Characteristics of Meadowfoam with Planting Dates and Rates. J. W. Johnson, M. B. Devine, G. A. White, R. Kleiman. *Agronomy Journal*

Miscellaneous Publications

921	Performance of Winter Barley and Winter Wheat in Maryland, 1976. J. W. Johnson.

930	The Tidal Marsh Soils of Maryland. R. G. Darmody, J. E. Foss.
931	Irrigation Studies with Maryland Tobacco. C. G. McKee, O. E. Street.
932	Effects of Ethephon on Yellowing and "Ripening" Stalk-Cut Maryland Tobacco. J. H. Hoyert.
934	A History of Maryland Tobacco Research. O. E. Street.
936	Miles, A New Soybean Variety for Maryland. W. J. Kenworthy, J. A. Schillinger.

ANIMAL SCIENCE

Projects

C-52	Supplementation of Corn Stover for Wintering Gestating Beef Cows. W. E. Kunkle, J. Buric, E. C. Leffel.
C-53	Jugular Vein Plasma Progestin Levels and Effect of Exogenous Progesterone Thereon. J. P. McCall, J. E. Dinger.
C-55	Effects of Iron Nutriture on Serum Proteins in Lead Poisoned Rats. J. V. DeBarthe, C. Stone.
C-56	Nutritional Ramifications of Trichostrongylosis. E. C. Leffel, C. McCullough, M. McCullough.
C-57	Radiographic Measurement of Bone Development in Rapidly Developing Foals on Two Levels of Calcium and Phosphorus. J. P. McCall, D. L. Campbell.
C-58	Equine In-Vivo Studies of Sperm Longevity. R. E. Bray, J. P. McCall, D. L. Campbell.
C-59	Hindgut Function in Nonruminants. J. V. DeBarthe, E. P. Young.
CD-54	Effect of Worming and Anabolic Agents on the Growth of Nursing Beef Calves. W. E. Kunkle, R. C. Hammond.

Scientific Articles

A2419	Plasma Progestin Levels in Pregnant Mares and the Effect of Exogenous Progesterone on Those Mares. J. E. Dinger, J. P. McCall. *Journal of Animal Science.*

BOTANY

Projects

F-12	Native Plants of Maryland. C. R. Broome, R. Brown.
F-21	Comparative Vegetative Anatomy of Flowering Plants. W. L. Stern.
F-24	Biosystematic Studies of North American Vascular Plants. J. L. Reveal.
F-25	Cytogenetics of Pepper, *Lilium regale* and Corn. D. T. Morgan.
J-93	Treatment of Soil and Underground Parts of Plants for the Control of Plant Diseases. O. D. Morgan, J. G. Kantzes.
J-98	Viral and Viral-like Diseases of Plants in Maryland. M. C. Corbett.
J-100	Virus and Mycoplasma Diseases of Deciduous Tree Fruits and Grapevines. M. C. Corbett, L. O. Weaver.
J-103	Production of Multiple Disease Resistant Type 32 Maryland Tobacco with Improved Quality and Yield. O. D. Morgan, M. K. Aycock.
J-107	Selection and Nature of Induced Mutations in Higher Plant Cells. P. J. Bottino.
J-109	Mode of Action, Metabolism and Field Performance of Fungicides. H. D. Sisler, J. G. Kantzes, N. N. Ragsdale.
J-110	The Impact of Nematode Population on Crop Yield. L. R. Krusberg, S. W. Andrews, D. J. Chitwood, D. E. Babineau, E. M. Dutky.
J-111	Corn Aflatoxins, Their Occurrence and Control. G. A. Bean.
K-13	Physiology of Chesapeake Bay Phytoplankton. E. P. Karlander.
K-14	Requirement for Potassium in Nitrogen Metabolism by Higher Plants. D. G. Blevins, N. M. Barnett.
K-15	Lipid Composition and Biosynthesis in Soybeans. G. W. Patterson.
K-16	Morphological, Ultrastructural and Biochemical Characterization of Nanoplankton from Chesapeake Bay. G. W. Patterson, S. D. Van Valkenburg.

Scientific Articles

A2364	The Growth Rate of *Mychonastes ruminatus* Simpson and Van Valkenburg Under Various Light, Temperature, and Salinity Regimes. P. D. Simpson, E. P. Karlander, S. D. Van Valkenburg. *British Phycological Journal*
A2374	Chromosome Numbers and Meiosis in North and Central American Species of *Centaurium* (Gentianaceae). C. R. Broome. *Systematic Botany*
A2386	The Fine Structure of *Uroglena Volvox* (Chrysophyceae). I. The Vegetative Cell. S. C. Esser, S. D.Van Valkenburg. *Journal of Phycology*
A2393	Role of Potassium and Malate in Nitrate Uptake and Translocation in Wheat Seedlings. D. G. Blevins, N. M. Barnett, W. B. Frost. *Plant Physiology.*
A2401	A Retrospective View of Comparative Anatomy, Phylogeny, and Plant Taxonomy. W. L. Stern. *Transacciones del V Congreso Venezolana de Botanica.*
A2408	A Comparison by Size, Class and Volume of Detritus Versus Phytoplankton in Chesapeake Bay. S. D. Van Valkenburg, J. K. Jones, D. R. Heinle. *Estuarine and Coastal Marine Science.*
A2410	Effect of Triarimol on Lipid Composition in Three Species of Chlorella. C. Frasinel, G.W. Patterson, S. R. Dutky. *Phytochemistry.*
A2413	Plant Cloning: Propagation of Plants Through Tissue Culture. P. J. Bottino. *The Science Teacher.*
A2438	Index Xylariorum. Institutional Wood Collections of the World. 2. W. L. Stern. *Taxon.*
A2441	The Effect of Steroids and Their Solubilizing Agents on Mycelial Growth of *Phytophthora cactorum*. W. D. Nes, G. W. Patterson, G. A. Bean. *Lipids.*
A2449	Proposed Outline for Status Reports on Threatened and Endangered Plant Species. M. S. Henifin, L. E. Morse, J. L. Reveal, B. MacBryde, J. I. Lawyer. *Geographical Data Organization for Rare Plant Conservation: A Symposium.*
A2450	The Concepts of Rarity and Population Threats in Plant Communities. J. L. Reveal. *Geographical Data Organization for Rare Plant Conservation: A Symposium.*

A2451 Synthesis of Sterols and Fatty Acids in Non-Photosynthetic Angiosperms. W. D. Nes, G. W. Patterson, M. A. Southall, J. L. Stanley. *Lipids.*

A2475 The Effect of Potato Leaf Sterols on Phytophthora infestans. W. J. Hazel, G. A. Bean. *Phytopathology.*

A2482 IAA Involvement in the Protective Mechanism of a Mycorrhizal Fungus Associated with Virginia Pine Seedlings. J. L. Sherwood, W. L. Klarman. Forest Science.

A2486 Expression of Disease Reaction Types in Soybean Callus from Resistant and Susceptible Plants. M. J. Holliday, W. L. Klarman. *Phytopathology.*

A2487 Fungicides. H. D. Sisler, N. N. Ragsdale. *Handbook in Agriculture.*

A2514 Soil Algae from a Maryland Serpentine Formation. D. E. Terlizzi, E. P. Karlander. *Soil Biol Biochem.*

CENTER FOR ENVIRONMENTAL AND ESTUARINE STUDIES

Projects

Z-1 Ecological Adaptation and Characteristics of 100 Geographic Populations of *Pinus strobus.* J. B. Genys.

Z-2 Tree Damage and Forest Management Implications of the Locust Borer *Megacyllene robinia,* in Maryland. D. Harman.

Scientific Articles

A2442 Susceptibility of Different Species, Clones and Strains of Pines to Acute Injury Caused by Ozone and Sulfur Dioxide. J. B. Genys, H. E. Heggestad. *Plant Disease Reporter.*

Technical Bulletins

A189 Intraspecific Variation of Eastern White Pine Studied in U.S.A., Germany, Australia and New Zealand. J. B. Genys *et al.*

COLLEGE OF HUMAN ECOLOGY

Projects

Y-7 Nutrition Improvement in the Northeast Region. L. C. Butler.

Y-10 Consumer, Market and Laboratory Studies of Flame Resistant Textile Items. B. F. Smith, S. M. Spivak, R. Dardis.

Y-11 Quality Housing Environment for Low-Income Families. G. S. Fish.

Y-12 An Analysis of Consumer Income and Expenditures. E. A. Hacklander, R. Dardis, F. W. Derrick.

Y-13 Development of Nutrition Education Curricula for Use in the Teams-Games-Tournament Teaching Program. L. A. Wodarski.

Scientific Articles

A2361 The Effects of Weathering and Atmospheric Pollutants on Cotton Fabric and Cotton Fabric Treated with Selected Flame Retardants. II. Spectroscopic Studies. B. L. Slaten, B. F. Smith. *Journal of Applied Polymer Science.*

A2362 The Effects of Weathering and Atmospheric Pollutants on Cotton Fabric and Cotton Fabric Treated with Selected Flame Retardants. I. Physical, Chemical and Flammability Properties. B. L. Slaten, S. M. Spivak, B. F. Smith. *Journal of Applied Polymer Science.*

A2395 A Fire Safety Program for Elementary Schools. J. Anderson, R. Dardis. *Proceedings of the 11th Annual Meeting — Information Council on Fabric Flammability, 1977.*

A2406 Teams-Games-Tournaments to Teach Nutrition. C. B. Lockshin, M. Tidball, L. A. Wodarski. *Nutrition News.*

A2424 Comparisons of Housing Quality. G. S. Fish. *Proceedings of the TVA-S-95 Workshop.*

A2447 Teaching Nutrition by Teams-Games-Tournaments. C. B. Lockshin, M. L. Tidball, L. A. Wodarski.

A2515 Flame Retardant Children's Sleepwear. I. Comparison of Home and Laboratory Laundering. L. F. Allison, K. Yeh, B. F. Smith. *Textile Chemist and Colorist.*

Technical Bulletins

A190 Satisfaction of Owners of Farmers Home Houses in Maryland. G. S. Fish.

Miscellaneous Publications

923 Workshop Proceedings, Action for Aging: Housing Options. M. M. Moore, G. S. Fish.

DAIRY SCIENCE

Projects

G-57 Development of a Controlled Ovulation and Pregnancy Program in Cattle. W. F. Williams.

G-58 Culture Studies on Sterile Milk. D. C. Westhoff.

G-59 Evaluation and Shelf-Life of Sterilized and Pasteurized Milk. D. C. Westhoff.

G-62 Development and Application of Processing Technology for Dairy and Related Foods. J. F. Mattick, R. L. King, D. C. Westhoff.

G-63 Utilization of Dairy and Related Food Processing Waste Products. J. F. Mattick, R. L. King.

G-64 Mechanism of Glycosylation of Bovine K-Casein. I. K. Vijay.

G-65 The Role of Membranes in the Secretion of Milk. I. H. Mather.

G-66 Optimizing Intake and Digestibility of Forages by Ruminants. R. F. Davis, J. H. Vandersall.

G-67	Biochemical Studies on Milk Processed by Falling Film Sterilizer. I. K. Vijay.
G-68	Effects of Essential Fatty Acid Deficiency on Brain Development. M. Keeney.
G-70	Resistance to Mastitis in Dairy Cattle (The Transport of Immunoglobins into Colostrum and Milk). I. H. Mather.
G-71	Regulation of Glycoprotein Synthesis. I. K. Vijay.

Scientific Articles

A2363	Milk Processed by a Falling-Film Pasteurizer-Sterilizer. II. Determination of Sporadical Efficiency in Water. D. C. Westhoff, S. Doores. *Journal of Dairy Science.*
A2367	Dietary Fat and Cancer Trends. M. C. Enig, R. J. Munn, M. Keeney. *Federation Proceedings.*
A2415	The Nutritive Value of Direct-Cut Alfalfa Ensiled with Various Types and Levels of Paper. T. L. Horn, J. H. Vandersall, L. W. Douglass. Abstracts, annual ASAS meeting.
A2434	Separation of the Proteins of Bovine Milk-Fat Globule Membrane by Electrofocusing. I. H. Mather. *Biochim. Biophts. Acta.*
A2435	Estradiol Receptors in Pubic Ligament Fibroblasts Maintained in Culture. W. F. Williams, D. R. Yver. Presentation at the Northeast Region ADSA and ASAS.
A2436	Transfer Coefficients for Acid-Soluble Orally Administered Radionuclides Secreted in Milk. W. F. Williams, D. D. Rockman, S. E. Hoar, D. Sam. Presentation at the Northeast Region ADSA and ASAS.
A2437	Possible Methods for the Utilization or Disposal of Fishery Solid Wastes. J. H. Green, J. E. Mattick. *Journal of Food Quality.*
A2445	A Method for the Determination of Protein in the Presence of Triton X-100. I. H. Mather, C. B. Tamplin. *Analytical Biochemistry.*
A2453	The Influence of Heat Treatment of Milk on Starter Activity: What About UHT? F. J. Feldstein, D. C. Westhoff. *Cultured Dairy Products Journal.*
A2454	Biosynthesis of N-acetylglucosaminylpyrophosphorylpolyisoprenol and N, N'-diacetylchitobiosylpyrophosphorylpolyisoprenol in Mammary Membranes. I. K. Vijay, D. E. Lewis. *Journal of Dairy Science.*
A2455	Heterogeneity of Lipid-linked Oligosaccharides in Mammary Glycoprotein Synthesis. I. H. Carmichael, I. K. Vijay. *Journal of Dairy Science.*
A2456	Incorporation of N-Acetylglucosamine into Different Products in Bovine Mammary Membranes. D. E. Lewis, I. K. Vijay. *Journal of Dairy Science.*
A2457	Glycoprotein Biosynthesis in Mammary Gland. I. K. Vijay, D. E. Lewis. *Federation Proceedings.*
A2464	Effect of Pre- and Post-Natal Essential Fatty Acid Deficiency on Brain Development and Myelination. M. C. McKenna, A. T. Campagnoni. *Journal of Nutrition.*
A2481	Factors Contributing to the Virulence of Three Strains of *Staphylococcus aureus* Isolated From Clinically Infected Bovine Mammary Glands. E. A. White, M. J. Paape, B. T. Weinland, I. H. Mather. *Proceedings of the Society of Experimental Biology and Medicine.*
A2547	Variation in the Interaction Among Strains of *S. aureus* and Polymorphonuclear Neutrophils (PMN). E. A. White, M. J. Paape, B. T. Weinland, I. H. Mather. *Federation Proceedings.*
A2548	Isoelectric Focusing of Mild Fat Globule Membrane Proteins. I. H. Mather. *Journal of Dairy Science.*
A2549	Immunological Analysis of Bovine Milk Fat Globule Membrane. D. S. Armstrong, I. H. Mather, M. G. Irving, M. M. Nichols. *Journal of Dairy Science.*
A2550	A Study of Virulence Factors for Three Strains of *Staphylococcus aureus.* E. A. White, M. J. Paape, B. T. Weinland, I. H. Mather. *Journal of Dairy Science.*

DIRECTOR'S OFFICE

Miscellaneous Publications

919	Directory of Publications: Maryland Agricultural Experiment Station
924	Current Research Related to Water Quality. C. S. Britt, editor.

ENTOMOLOGY

Projects

H-74	Biology and Control of Tobacco Insects. F. P. Harrison.
H-103	The Circulatory System of Insects. J. C. Jones, M. Clark, M. Schauff.
H-104	Aquatic Insects in Maryland. W. E. Bickley.
H-106	Management and Suppression of Destructive Insects on Soybeans and Alfalfa. A. L. Steinhauer, L. M. Stevens, P. A. Zungoli, I. M. Suzenauer.
H-107	Nantucket Pine Tip Moth — Parasite Relationships and Damage in Loblolly Pine Plantings. A. L. Steinhauer, A. R. Giron.
H-108	Studies on the Biology of Mosquitoes. J. C. Jones, T. M. Tadkowski.
H-109	Mutation Potential of Specific Baculoviruses Designated for Insect Control. C. F. Reichelderfer.
H-110	Handbook of the Armored Scale Insects of Economic Importance in Maryland. J. A. Davidson.
H-111	Control of Orchard and Vineyard Pests. E. R. Krestensen.
H-112	Biology and Control of Vegetable Insects. J. J. Linduska, F. P. Harrison, W. E. Bickley.
H-113	Biology, Ecology and Control of Insects Affecting Sweet Corn. F. P. Harrison.
H-114	Habitat Relationships and Roost Management of Flocking Blackbirds and Starlings. D. H. Messersmith.
H-115	Biology of Stored Product Pests and Their Susceptibility to Microsporidan Infections. E. Armstrong.
H-116	Honey Bee Pollination: Effects of Management and Pests on Honey Bee Populations. D. M. Caron.
H-117	Insects on Turf and Economically Important Native Grasses in the State of Maryland: An Ecosystem Approach. R. F. Denno.

H-118	The Biology and Control of Insect and Mite Pests of Ornamental Plants in Maryland. J. A. Davidson.
H-120	The Metabolism and Fate of Pesticides and Their Residues in or on Agricultural Commodities. R. E. Menzer, J. O. Nelson.
H-121	Agricultural Pesticide Impact Assessment. A. L. Steinhauer.
H-122	Decision-Making and Biological Monitoring Methodology for Field Crop Pest Management. G. P. Dively, F. P. Harrison.
H-123	Exploration for and Introduction and Colonization of Parasites of the Mexican Bean Beetle. A. L. Steinhauer, A. R. Giron.
H-124	Colonization, Biology and Behavior of the Nantucket Pine Tip Moth and its Two Major Parasites. A. L. Steinhauer, A. R. Giron, W. L. Murphy.
H-126	Pest Management Strategies for Tobacco Budworm and Tobacco Hornworm in Maryland. F. P. Harrison.
H-127	Biology and Control of Vegetable Insects. J. J Linduska.
H-129	Selection of More Virulent Baculoviruses by Chemical Mutagenesis. C. F. Reichelderfer, J. T. McClintock.

Scientific Articles

A2373	Endogenous Synthesis of Lipid Yolk in Mosquito Oocytes. T. M. Tadkowski, J. C. Jones. *Experientia.*
A2376	The Structure of the Aquatic Insect Community Associated with Intertidal Pools on a New Jersey Salt Marsh. B. C. Campbell, R. F. Denno. *Ecological Entomology.*
A2382	The Influence of Path Size on a Guild of Sap-Feeding Insects that Inhabit the Salt Marsh Grass *Spartina Patens.* M. J. Raupp, R. F. Denno. *Ecological Entomology.*
A2396	*Wyeomyia haynei* in Maryland. W. E. Bickley, J. Mallack. *Mosquito News.*
A2397	The Adaptiveness of Wing-Dimorphism in the Salt Marsh-Inhabiting Planthopper, *Prokelisia marginata* (Homoptera: Delphacidae). R. F. Denno, E. E. Grissell. *Ecology.*
A2411	A Note on the Use of the Terms Instar and Stadium. J. C. Jones. *Annals of the Entomological Society of America.*
A2414	Corn Earworm: Field Evaluation of Resistance in Sweet Corn. J. J. Linduska, F. P. Harrison. *Journal of Economic Entomology.*
A2425	Evaluation of Soil Systemics for Control of Colorado Potato Beetle on Tomatoes in Maryland. J. J. Linduska. *Journal of Economic Entomology.*
A2433	*Eupteromalus viridescens* (Walsh), a New Parasite Association for *Pediobius foveolatus* (Crawford) and *Epilachna varivestis* (Mulsant). P. A. Zungoli. Proceedings of the Washington Entomological Society.
A2439	Control of Primary and Secondary Infestations of Dusky Sap Beetle, *Carpophilus lugubris.* F. P. Harrison, J. C. Richardson. *Journal of Economic Entomology.*
A2443	Control of Wireworms on Sweet Potatoes in Maryland. J. J. Linduska. *Journal of Economic Entomology.*
A2465	Changes in the Fat Body and Oocysts during Starvation and Vitellogenesis in a Mosquito, *Aedes Aegypti* (L.). T. M. Tadkowski, J. C. Jones. *Journal of Morphology.*
A2500	Relative Acceptability of Bird and Human Blood to the Northern House Mosquito. M. D. Buescher, W. E. Bickley. *Mosquito News.*
A2504	Swarm Emergence Date and Cluster Location in Honey Bees. D. M. Caron. *American Bee Journal.*
A2505	Queen Cup and Cell Production in *Apis mellifera* Colonies. D. M. Caron. *Journal of Apicultural Research.*
A2506	Effects of Some ULV Mosquito Abatement Insecticides on Honey Bees. D. M. Caron. *Journal of Economic Entomology.*

HORTICULTURE

Projects

I-60	Perceptions of Scenic Resources in the Rural Landscape. D. G. Pitt.
I-74-A	Effect of Environmental Factors and Cultural Practices on the Growth and Flowering of Plant Crops. J. B. Shanks.
I-74-B	Effect of Environmental Factors and Cultural Practices on the Growth and Flowering of Greenhouse Cut Flower Crops. J. B. Shanks.
I-74-C	Cultural-Management Studies — Woody Plants. C. B. Link, F. R. Gouin
I-79-N	Control of Growth and Flowering of the Carnation. J. B. Shanks, C. B. Link.
I-79-O	Mineral Nutrients, Cultural Techniques and Winter Survival of Woody Ornamentals. C. B. Link, F R. Gouin
L-73	Adaptation of Fruit Varieties and New Seedlings to Maryland. A. H. Thompson, H D. Stiles.
L-74-B	Chemical Thinning of Apples and Peaches. A H. Thompson, B. L. Rogers.
L-79-G	Control of Postharvest Decay of Fruits and Vegetables. T Solomos, J. A. Merkel.
L-79-J	Use of CA Storage and Chemicals to Prolong Marketing Life of Apples, Potato Tubers and Cut Flowers. T Solomos, R C. Wiley.
L-101	Composted Sewage Sludge in Forest Nursery Seedling Production. C. B. Link, F. R. Gouin, J. F. Kundt.
L-103	Forest Tree Planting Trials. F. D. Schales, J. F. Kundt.
L-105	Pine Tree Response to Composted Sewage Sludge. J F. Kundt, F D. Schales.
LH-75-A	Influence of Summer Shearing and Nitrogen on Yield and Quality of Peaches in High Density. A H. Thompson, B. L. Rogers, E. R. Krestensen, T. Solomos.
Q-58-K	Development of Specifications for Canned Food Quality. A. Kramer.
Q-58-N	Suitability of New Varieties of Horticultural Crops for Canning and Freezing. F. D. Schales.
Q-58-W	Quality Maintenance and Control in the Marketing and Storage of Vegetables. A. Kramer.
Q-58-X	Quality Maintenance and Control in the Marketing and Storage of Vegetables. T. Solomos, J. C. Bouwkamp.
Q-60-A	Functional Properties of Proteins. A. Kramer, J. C. Bouwkamp, R C. Wiley.

Q-74	A Study of Regional Adaptation of Certain Vegetable Crops and Varieties in Maryland. C. W. Reynolds, F. D. Schales.
Q-77	Crop Management Studies with Vegetable Crops. C. W. Reynolds, F. D. Schales.
Q-77-B	Efficacy and Selectivity of Herbicides for Weed Control in Truck Crops. C. E. Beste, F. D. Schales.
Q-77-C	Interrelations of Cultural Procedures to the Mechanical Harvesting of Tomatoes. J. C. Bouwkamp, C. E. Beste, C. A. McClurg.
Q-77-E	Weed-Crop Competition — Tomatoes. C. E. Beste, F. D. Schales.
Q-81	Cantaloupe Breeding and Selection. J. C. Bouwkamp, T. J. Ng.
Q-81-A	Breeding and Selection of Fresh Market and Processing Tomatoes. J. C. Bouwkamp.
Q-81-D	Tomato Breeding and Selection with Particular Reference to Adaptation to Mechanical Harvesting and Processing. J. C. Bouwkamp.
Q-81-F	Breeding of Horticultural Crop Plants. J. C. Bouwkamp, C. B. Link, J. B. Shanks.
Q-81-G	Genetics and Physiology of Sweet Corn Quality and Biological Efficiency. R. C. Wiley.
Q-81-H	Discovery and Preservation of Valuable Plant Germ Plasm. J. C. Bouwkamp, T. J. Ng.
Q-83	The Dynamics and Energetics of the Soil-Plant-Atmosphere Continuum (SPAC). C. W. Reynolds.
QR-84-C	Simultaneous Fruit and Vegetable Drink and Concentrate Production and Waste Water Purification by Directional Cooling. A. Kramer, F. W. Wheaton, A. Olowofoyeku.
Q-84-D	Development of New Products and Improved Processing Methods. R. C. Wiley, A. Kramer.
Q-84-E	Balancing Costs vs. Sensory and Nutritional Gains in Refrigerated Storage of Foods. A. Kramer, F. E. Bender.
L-74	Environmental Factors and Cultural Practices in Relation to the Growth and Fruiting Responses of Fruits. A. H. Thompson, B. L. Rogers, H. D. Stiles.
L-74-D	Investigations in High Density Plantings of Apple, Peach and Pear. A. H. Thompson, B. L. Rogers.

Scientific Articles

A2371	Ontogeny of Dwarf Apices of *Pinus ponderosa*. M. A. Cohen, J. B. Shanks. *Journal of the American Society for Horticultural Science*.
A2379	Continuous Diffusion-Extraction Method to Produce Apple Juice. C. R. Binkley, R. C. Wiley. *Journal of Food Science*.
A2380	An Evaluation of Napromide for Transplanted Tomatoes. C. E. Beste. *Proceedings of the Northeastern Weed Science Society*, Volume 32.
A2388	Sharing Power with the Federal Power Commission. B. W. Sorter, D. G. Pitt. *Journal of the American Institute of Planners*.
A2394	Energy Savings During Frozen Food Storage. B. H. Ashby, A. H. Bennett, W. A. Bailey, W. Moleeratanond, A. Kramer. *Proceedings of the American Society of Agricultural Engineers*.
A2399	Whitefly Infestation on Chrysanthemum and Poinsettia Treated with Plant and Insect Growth Regulators. S. J. Fischer, J. B. Shanks. *Journal of the American Society for Horticultural Science*.
A2400	Recovery of Betalaines from Red Beets by a Diffusion Extraction Procedure. R. C. Wiley, Y. N. Lee. *Journal of Food Science*.
A2416	Variation in Betalaine Content Among Table Beet Cultivars. T. J. Ng, Y. N. Lee. *HortScience*.
A2417	Forest Seedlings Thrive on Composted Sludge. F. R. Gouin, C. B. Link, J. F. Kundt. *Compost Science, The Journal of Waste Recycling*.
A2432	Effects of Post-Harvest Sprays of 2, 4, 5 triclorophenoxypropionic acid on Fruitfulness of "Magness" Pears. B. L. Rogers, A. H. Thompson. *Fruit Varieties Journal*.
A2444	Advances in Food Technology Affecting Refrigeration. A. Kramer. Research paper 78-1, The Refrigeration Research Foundation, Washington D.C.
A2448	Benefits/Risks: Color Additives. A. Kramer. *Food Technology*.
A2458	Results with Several Chemicals on Thinning Spur-Type Delicious Apple Trees. B. L. Rogers. *Pennsylvania Fruit News*.
A2459	Effects of Freezing and Frozen Storage on Nutrient Retention of Selected Fruits and Vegetables. A. Kramer. Presented at the Institute of Food Technology Annual Meeting.
A2460	Development of High-Protein Date Bars and Their Stability at Different Storage Temperatures. B. S. Kamel, A. Kramer. *Journal of Food Quality*.
A2463	A Comparison of the Farinograph and a Modified Shear-Press for Measuring the Rheological Properties of Dough and its Finished Products. S. Sirivichayapornlert, A. Kramer. *Journal of Texture Studies*.
A2466	Effect of Fluctuating Temperatures on Energy Consumption and Quality Changes of Palletized Frozen Foods During Storage. W. Moleeratanond, A. Kramer, B. H. Ashby, W. A. Bailey, A. H. Bennett. Presented at the Institute of Food Technology Annual Meeting.
A2470	Some Significant Mileposts in Growth and Development in Pomology. A. H. Thompson. *HortScience*.
A2472	Chemical Promotion of Branching in Poinsettia (*Euphorbia pulcherrima* Willd. ex Klotzch) and Chrysanthemum (*C.* x *Morifolium* Ramat.) in the Greenhouse. J. B. Shanks, A. Purohit. Proceedings of the Plant Growth Regulator Working Group, 1978.
A2473	Freeze Concentration of Apple Juice by Rotational Unidirectional Cooling. A. K. Olowofoyeku, D. Gil, A. Kramer. *Journal of Food Process Engineering*.
A2474	Desalination of Saline Water by Rotational Unidirectional Cooling. A. K. Olowofoyeku, D. Gil, A. Kramer. *Journal of Food Process Engineering*.
A2483	Effect of Consuming Food Supplemented with Single Cell Protein on Urine and Serum Uric Acid Levels. B. S. Kamel, A. Kramer. *Journal of Food Safety*.

A2494 Efficiency Studies of a Continuous Diffusion Apparatus for the Recovery of Betalaines from the Red Table Beet. R. C. Wiley, Y. N. Lee, J. J. Saladini, R. C. Wyss, H. H. Topalian. *Journal of Food Science.*

A2495 Comparison of Rat Tetrahymena Pyriformis Growth Assays in Determining Nutritional Quality of Protein in Meat and Meat Analogs During Prolonged Storage at Various Temperatures. R. R. Butrum, A. Kramer. *Journal of Food Quality.*

A2501 Testing Oriental Persimmons for Maryland: A Progress Report. J. B. Shanks. *The North American Pomona.*

A2503 Controlling Brambles with Glyphosate in Established Christmas Tree Plantations. F. R. Gouin. *HortScience.*

A2509 The Effect of Protein Fortification on the Acceptibility and Rheological Properties of Dough and its Final Product. S. Sirivichayapornlert, B. S. Kamel, A. Kramer. *Journal of Texture Studies.*

Miscellaneous Publications

917 The "Redskin" and "Mar" Series Peach Cultivars: Their Origin and Description. R. C. Funt, S. H. Todd, G. J. Stadelbacher.

922 An Economic Comparison of Several Small Fruit Production and Harvest Systems in Maryland. R. C. Funt.

POULTRY SCIENCE

Projects

M-66 Applied Broiler Nutrition Studies. O. P. Thomas, E. L. Johnson.

M-74 Recycling Broiler Litter Through Ruminants. W. E. Kunkle, L. E. Carr, O. P. Thomas.

M-108 Studies of Methods in Poultry Processing Plants and Hatcheries to Reduce Pollution. W. C. Merka, L. E. Carr, W. J. Kuenzel.

M-110 Morphological and Physiological Studies of an Epileptiform Seizure Pattern in Chickens, *Gallus domesticus.* W. J. Kuenzel, M. M. Schaefer.

M-111 Cleaning and Preservation of Shell Eggs Without Refrigeration. J. L. Heath.

M-112 Metabolic Rates, Vital Signs, Body Temperature and the Control of Food Intake in Growing Chicks. W. J. Kuenzel, J. H. Walther.

M-113 Poultry Product Quality. J. L. Heath.

M-114 Endocrine Involvement in the Reproductive Capability of the Maturing and Aging Bird. M. A. Ottinger.

M-212 Nutritional Improvement in the Northeast Region. M. Rubin, O. P. Thomas.

M-213 Interrelationship of Selenium and Cystine with Mercury. J. H. Soares, L. J. Kling.

M-214 The Effects of Diet on the Toxicity of Lead in Quail, Mallard Ducks and Chickens. J. H. Soares.

M-216 Amino Acid Requirements of Broilers and Laying Hens. O. P. Thomas, E. H. Bossard, J. H. Soares.

M-217 Eggshell Quality in Avian Species. J. H. Soares.

M-218 Mycotoxins in Poultry Production. J. A. Doerr.

Scientific Articles

A2366 Heart Beat, Blood Pressure, Respiration and Brain Waves of Broilers as Affected by Electrical Stunning and Bleed-Out. W. J. Kuenzel, J. H. Walther. *Poultry Science.*

A2368 Gaseous Metabolism of Leghorns and Broilers During Early Growth: Resting Metabolic Rate. D. M. Denbow, W. J. Kuenzel. *Poultry Science*

A2369 Effect of Oiling Variables on Storage of Shell Eggs at Elevated Temperatures. J. L. Heath, S. L. Owens. *Poultry Science.*

A2370 Influence of Diets Containing Rye or Pectin on the Intestinal Flora of Chicks. D. D. Wagner, O. P. Thomas. *Poultry Science*

A2375 The Effects of Vitamin E Deficiency on Hepatic Xanthine Dehydrogenase Activity, Lead and α-Tocopherol Levels in Tissues of Lead Poisoned Mallard Ducks. R. B. Sleet, J. H. Soares. *Toxicology and Applied Pharmacology.*

A2377 Brain Noradrenaline Concentration in Seizure-Prone Chicks, *Gallus domesticus* M. M. Schaefer, W. J. Kuenzel. *Poultry Science.*

A2381 Phosphorus Availability I. The Effect of Chick Age and Vitamin D Metabolites on the Availability of Phosphorus in Deflourinated Phosphate. J. H. Soares, M. R. Swerdel, E. H. Bossard. *Poultry Science*

A2384 Mercury Metabolism in Japanese Quail. II. The Effects of Dietary Mercury and Selenium on Blood and Liver Glutathione Peroxidase Activity and Selenium Concentration. L. J. Kling, J. H. Soares. *Poultry Science.*

A2385 Mercury Metabolism in Japanese Quail. I. The Effect of Dietary Mercury and Selenium on Their Tissue Distribution. L. J. Kling, J. H. Soares. *Poultry Science*

A2398 Feed and Water Management of the Broiler Chick for the First 72 Hours. P. V. Twining, J. L. Nicholson, O. P. Thomas. *Poultry Science.*

A2418 Factors Affecting Quality, Yields and Consumer Acceptance of Broiler Halves. J. L. Heath. *Poultry Science*

A2423 The Effect of Selenium on the Biliary Excretion and Tissue Deposition of Two Forms of Mercury in the Broiler Chick. D. A. Rubenstein, J. H. Soares *Poultry Science.*

A2502 The Effectiveness of the Vitamin D Analog 1α-OH-D_3 in Promoting Fertility and Hatchability in the Laying Hen. J. H. Soares, M. R. Swerdel, M. A. Ottinger *Poultry Science*

A2507 Effect of Microwave Energy on Poultry Tenderness. N. A. Dunn, J. L. Heath. *Journal of Food Science.*

A2512 *Eimeria meleagrimitis* in Young Turkeys: Effects on Weight, Blood and Organ Parameters. P. C. Augustine, O. P. Thomas. *Journal of Parasitology*

A2513 Effects of Vitamin D_3 Metabolites and Egg Shell Calcification in Japanese Quail. D. M. Kaetzel, J. H. Eoares. *Journal of Nutrition.*

A2516 The Effects of Vitamin E on the Ethanol Metabolizing Liver in the Rat. J. S. Hannah, J. H. Soares. *Journal of Nutrition*

VETERINARY SCIENCE

Projects

D-63	Virology of the Bovine Respiratory Complex. S. B. Mohanty.
D-70	Virology of Equine Respiratory Disease Complex. S. K. Dutta.
D-71	Adequacy of Thermoregulatory Response to Cold Stress as a Factor in Decreased Disease Resistance. T. F. Albert, A. L. Ingling.
D-73	Veterinary Support for University of Maryland Animals. D. L. Campbell, J. P. Davidson, R. C. Hammond.
D-74	Detection and Control of Three Economically Important Avian Diseases. W. W. Marquardt, R. B. Johnson.
D-75	Infectious Laryngotracheitis (ILT), Avian Influenza (AI) and Infectious Bursal Disease. W. W. Marquardt, R. B. Johnson.
DC-76	Study of Equine Estrous Cycle with Emphasis on Hormone Control of the Cycle. D. L. Campbell, A. M. Pope, J. P. McCall.

Scientific Articles

A2378	Differentiation of Avian Coronavirus Serotypes by Immune Electron Microscopy Agglutination. W. F. Odenwald, R. B. Johnson, W. W. Marquardt, F. M. Hetrick. *Journal of Clinical Microbiology*
A2462	Cell Mediated Immunity to Bovine Rhinovirus Type I in Calves. A. Hussain, S. B. Mohanty. *Infection and Immunity*
A2469	Uterine Histology of Postpartum Mares Treated with Progesterone and GnRH. A. M. Pope, D. L. Campbell, J. P. Davidson. *Journal of Reproduction and Fertility.*
A2496	Cell Mediated and Humoral Immunity in Equine Herpesvirus Type I Infection: Lymphocyte Subpopulation Dynamics and Their Response to Mitogens in Experimentally Infected Ponies. M. K. Bumgardner, D. L. Campbell, S. K. Dutta. *The Journal of Infectious Diseases.*
A2499	Cell Mediated and Humoral Immunity in Equine Herpesvirus Type I Infection: Presence of Antibody-Dependent Complement-Mediated Cytotoxicity and Blastic Transformation in Response to Virus and Mitogen in Experimentally Infected Ponies. S. K. Dutta, D. L. Campbell, M. K. Bumgardner. *The Journal of Infectious Diseases.*

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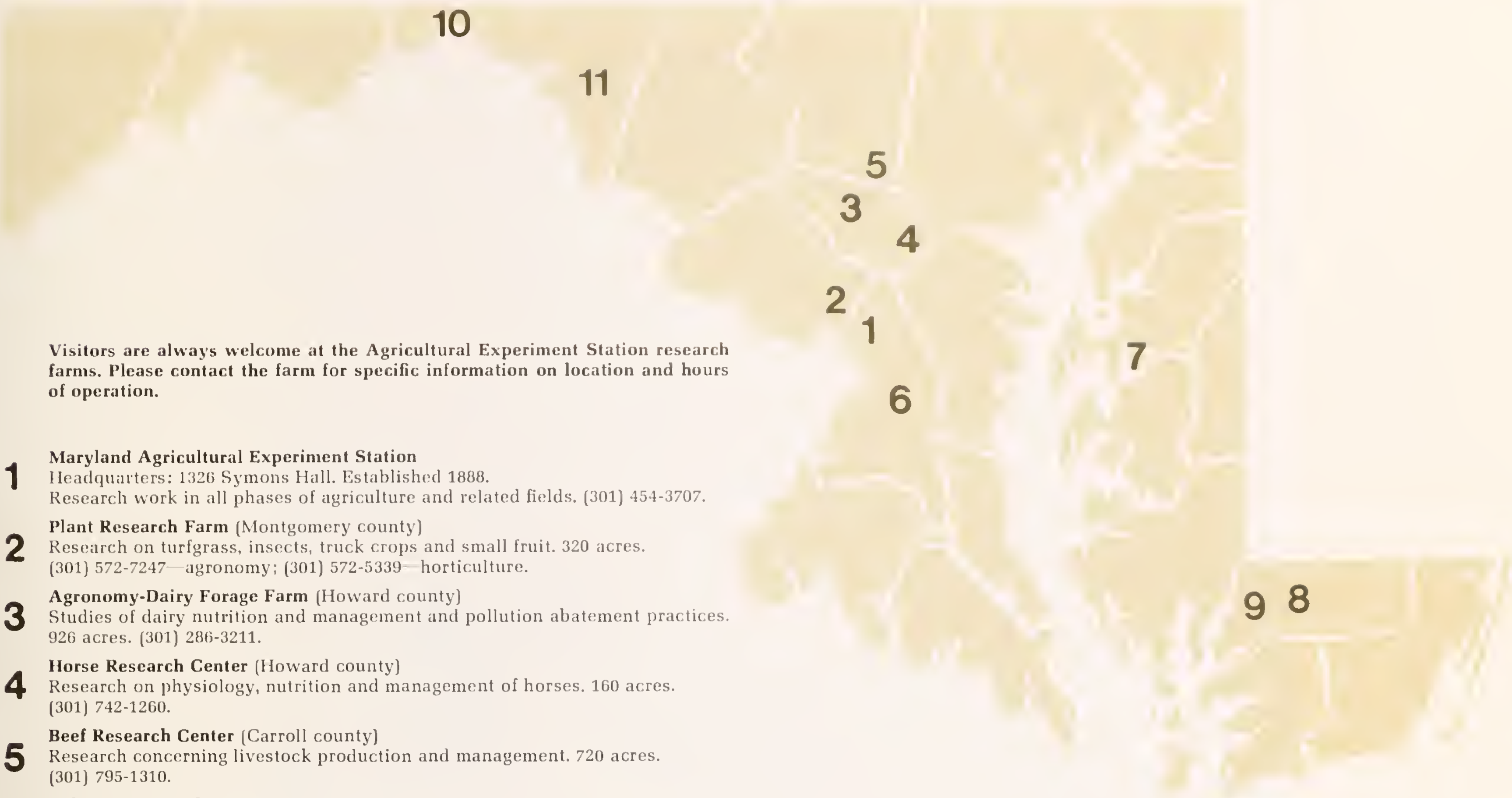
Financial Statement 1977-78

SOURCES OF INCOME		
Hatch Formula Funds		
¼ of Federal FY 77 Funds (1,003,098)	$250,775	
¾ of Federal FY 78 Funds (1,113,497)	835,123	$1,085,898
Hatch Regional Funds		
¼ of Federal FY 77 Funds (350,584)	87,646	
¾ of Federal FY 78 Funds (392,997)	294,748	382,394
McIntire-Stennis Funds		
¼ of Federal FY 77 Funds (113,660)	28,415	
¾ of Federal FY 78 Funds (143,289)	107,467	135,882
Rural Development Funds		
¼ of Federal FY 77 Funds (17,723)	4,431	
¾ of Federal FY 78 Funds (17,723)	13,292	17,723
Total Federal Funds		1,621,897
State Appropriation Per State FY 78 Budget		3,385,019
Total Funds		**$5,006,916**

EXPENDITURES BY MAJOR RESEARCH AREAS	Percentage	Amount
Natural Resources and Environmental Quality	13	$ 649,567
Forestry Production	3	117,890
Field and Horticultural Crops	34	1,718,656
Animals and Poultry	37	1,855,727
People, Communities and Institutions: Nutrition, Food Safety, Clothing and Housing	6	297,022
Marketing, Trade, Price and Income Policy	5	254,231
General Resource Technology	2	113,823
Total	**100**	**$5,006,916**

Maryland's Research Farms



Visitors are always welcome at the Agricultural Experiment Station research farms. Please contact the farm for specific information on location and hours of operation.

1 **Maryland Agricultural Experiment Station**
Headquarters: 1326 Symons Hall. Established 1888.
Research work in all phases of agriculture and related fields. (301) 454-3707.

2 **Plant Research Farm** (Montgomery county)
Research on turfgrass, insects, truck crops and small fruit. 320 acres.
(301) 572-7247—agronomy; (301) 572-5339—horticulture.

3 **Agronomy-Dairy Forage Farm** (Howard county)
Studies of dairy nutrition and management and pollution abatement practices. 926 acres. (301) 286-3211.

4 **Horse Research Center** (Howard county)
Research on physiology, nutrition and management of horses. 160 acres.
(301) 742-1260.

5 **Beef Research Center** (Carroll county)
Research concerning livestock production and management. 720 acres.
(301) 795-1310.

6 **Tobacco Research Farm** (Prince George's county)
Research relating to tobacco breeding, production, harvesting and curing. 206 acres. (301) 627-3273.

7 **Wye Research Center** (Queen Anne's county)
Work on plant breeding, weed and disease control, and production systems for corn, soybeans, vegetables and ornamentals. 125 acres. Additional research in cooperation with Wye Institute. 220 acres. Work with Wye Angus herd. Approximately 400 acres on Wye Plantation. (301) 827-7388.

8 **Salisbury Research Substation** (Wicomico county)
Experimental studies dealing with poultry and breeding, insect, pest and disease control, production systems and management and processing of vegetable crops. 89 acres. (301) 742-8788.

9 **Poplar Hill Research Farm** (Wicomico county)
Studies of disease control, breeding, pest control and production systems for corn, soybeans and vegetable crops. 100 acres. (301) 742-9644.

10 **Fruit Research Center** (Washington county)
Research on fruit production, disease control and fruit insects. 28 acres (leased). (301) 578-6718.

11 **Sharpsburg Research and Education Center** (Washington county)
Research on fruits, vegetables, ornamentals, field crops, soils and disease and insect control. 546 acres. (301) 578-6718.

College Park campus — headquarters of the Maryland Agricultural Experiment Station

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